APTIC # 20878

0940

PB 207 851

AN INVESTIGATION OF DIESEL-POWERED VEHICLE ODOR AND SMOKE

PART III

for

Division of Motor Vehicle Pollution Control
National Air Pollution Control Administration
Contract No. PH 22-68-23
Public Health Service
Department of Health, Education, and Welfare

FINAL REPORT

Southwest Research Institute
8500 Culebra Road
San Antonio, Texas 78228

October 1969

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
Springfield, Va. 22151

BIBLIOGRAPHIC DATA SHEET

1. Report No. APTD-0940

2.

3. Recipient's Accession No.

4. Title and Subtitle
An Investigation of Diesel-Powered Vehicle Odor and Smoke - Part III

5. Report Date October 1969

6.

7. Author(s)
Karl J. Springer

8. Performing Organization Rept. No. AR-695

9. Performing Organization Name and Address
Southwest Research Institute
8500 Culebra Road
San Antonio, Texas 78228

10. Project/Task/Work Unit No.

11. Contract/~~Grant~~ No.
PH 22-68-23

12. Sponsoring Organization Name and Address
Department of Health, Education, and Welfare
Public Health Service
National Air Pollution Control Administration
Division of Motor Vehicle Pollution Control

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstracts
A ten-person odor panel, trained in the characterization of dilute diesel exhaust samples according to the PHS quality/intensity rating kit and the PHS light-extinction smokemeter, were used to measure odor and smoke. A commercially available diesel fuel odor additive had no effect on perceived odor from three two-cycle Detroit diesel 6V-71 E powered municipal buses, and inconsistent reductions in odor generally resulted from a catalytic muffler device, although certain of the chemical emissions such as hydrocarbons and carbon monoxide were generally always reduced. Both odor and smoke were less from similar buses powered by a 6V-71 N type engine. A number of truck-tractors with a variety of engines and drivelines were evaluated to develop dynamometer procedures and acquire limited baseline emissions. Due to low exhaust temperature and unsteady flow conditions with extended engine idle, the city bus exhaust represents one of the most difficult to treat by catalysis, and a number of catalytic devices employing both transition metal and precious metal catalyst coatings were unsatisfactory. An electrostatic precipitator was completely unsuccessful in reducing smoke according to the smokemeter, while fuel seemed to have little or no effect on perceived odor from three buses powered by 8V-71 N engines. A modified needle type or 'N' injector resulted in lower smoke, odor, and other emissions such as HO, CO, and acrolein under all conditions investigated. Correlation studies were undertaken to develop an instrumental technique to extend the usefulness of the trained odor panel, including the measurement of total hydrocarbons, carbon monoxide, carbon dioxide, nitric oxide, nitrogen dioxide and total aldehydes, formaldehyde and acrolein.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution
Exhaust emissions
Motor vehicles
Odors
Smoke
Particles
Diesel engines
Buses (vehicles)
Motor trucks
Odor detection
Measurement
Electrostatic precipitators
Catalytic converters
Fuel additives
Odor control
Acroleins
Formaldehyde
Carbon monoxide
Dynamometers
Carbon dioxide

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 13B

18. Availability Statement
Unlimited

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page) UNCLASSIFIED

21. No. of Pages 782

22. Price

FORM NTIS-35 (10-70)

USCOMM-DC 40329-P71

No. AR-695

Vehicle Emissions Research Laboratory

AN INVESTIGATION OF DIESEL-POWERED VEHICLE ODOR AND SMOKE

PART III

Karl J. Springer

Details of illustrations in this document may be better studied on microfiche

for

Division of Motor Vehicle Pollution Control
National Air Pollution Control Administration
Contract No. PH 22-68-23
Public Health Service
Department of Health, Education, and Welfare

FINAL REPORT

Southwest Research Institute
8500 Culebra Road
San Antonio, Texas 78228

October 1969

Reviewed:

John M Clark

John M. Clark
Department Director

Approved:

Henry J Korp

Henry Korp, Vice President
Engines, Fuels, and Lubricants Division

FOREWORD

This project was initiated by the Division of Motor Vehicle Pollution Control, National Air Pollution Control Administration, United States Public Health Service, Department of Health, Education, and Welfare, Willow Run Airport, Ypsilanti, Michigan. The engineering effort upon which this report is based was accomplished by Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas, under Contract CPA 22-69-71 entitled "Preparation of a Guide to Good Practice for Diesel Powered Vehicles." The author, Mr. Karl J. Springer, was the Project Leader of the research and development work. This program started on May 1, 1969, and was completed November 30, 1969.

The Project Officer cognizant of this program was Mr. Ralph C. Stahman, Chief, Emission Control Engineering Branch, Division of Motor Vehicle Pollution Control, National Air Pollution Control Administration, U.S. Public Health Service, Department of Health, Education, and Welfare, Willow Run Airport, Ypsilanti, Michigan 48197. This project was identified within Southwest Research Institute as No. 11-2600.

ABSTRACT

This is the third in a series of reports resulting from the "Long Range Investigation of Diesel-Powered Vehicle Odor and Smoke" sponsored by the National Air Pollution Control Administration, Department of Health, Education and Welfare. Using procedures, facilities, and instrumentation developed and improved during Parts I and II, this 16-month-long effort concentrated on control technology and odor correlation studies. To illustrate current state-of-the-art, similar 6-month fleet tests of a catalytic muffler and a diesel fuel odor additive were made in municipal buses powered by Detroit Diesel Division (GMC) 6V-71 E two-cycle diesel engines. Periodic measurements (before, during, and after the test period) were made to determine effectiveness on odor, smoke, and other exhaust emissions of interest. Odor and smoke measurements were made of a group of ten buses powered by the higher compression ratio 6V-71 N engine and statistically compared to a similar group of E engines evaluated during Part I. A number of truck-tractors with a variety of engines and drivelines (transmission and axle arrangements) were evaluated to develop dynamometer procedures and acquire limited baseline emissions. Several intercity buses powered by 8V-71 N two-cycle engines were operated to gain basic information on emissions from this vehicle using both a No. 1 and 2 diesel fuel. Studies were conducted to crosscheck the Bureau of Mines and SwRI odor panels and to determine the potential of experimental catalytic muffler devices and fuel injectors. An electrostatic precipitator for smoke removal was reevaluated after an unsuccessful trial during Part II. The objective of the odor correlation studies was to develop an instrumental technique to extend the usefulness of the trained odor panel. These studies included the measurement of total hydrocarbons, carbon monoxide, carbon dioxide, nitric oxide, nitrogen dioxide and total aldehydes, formaldehyde and acrolein simultaneously with odor ratings by the panel. Bag samples of exhaust for cold trapping and gas liquid chromatograph analyses of trapped polar compounds were also obtained. An eleven-vehicle correlation study included eight two-cycle and three four-cycle diesel powered buses and trucks. Equations relating "D," "B," "O," "A," and "P" odor panel ratings to the various exhaust parameters were determined as a result of multiple linear regression analysis. The exhaust measurements most helpful in predicting diesel odor ratings are identified. Recommendations for future work efforts are offered.

TABLE OF CONTENTS

Preceding page blank

Page

FOREWORD vii

ABSTRACT xi

I. INTRODUCTION 1

A. Review of the Part I Project 1
B. Review of the Part II Project 1
C. Objective and Approach 2
D. Participation in Coordinating Research Council Activities 2
E. Presentation of Technical Papers 3
F. Diesel Odor Contractors Workshop 3

II. DESCRIPTION OF FACILITY, EQUIPMENT, AND FUELS 4

A. Diesel Emissions Measurement Facility 4

1. Measurement Methods 4
2. Odor Facility 6
3. Laboratory Road Simulation Facility 7

B. Equipment and Instruments 10
C. Description of Fuels 14

III. FLEET TEST OF A DIESEL FUEL ODOR ADDITIVE 16

A. Initial Screening Tests 16
B. Fleet Test 21

1. Approach 21
2. Test Preparations 21
3. Results 23
4. Cost Effectiveness 24

IV. FLEET TEST OF CATALYTIC MUFFLER 33

A. Screening Tests - Initial 33

1. Description of Devices 33
2. Results of Initial Screening Tests 36
3. Summary of Initial Screening Tests 44

B. Additional Screening Tests 44

1. Description of Devices Evaluated 44
2. Results of Additional Screening Tests 47

C. Fleet Test of Code "W" Muffler 52

1. Preparations 52
2. Results 53

TABLE OF CONTENTS (Cont'd)

Page

3. Cost Effectiveness 71
4. Summary 71

V. BUS ODOR AND SMOKE VARIABILITY 72

A. Objective 72
B. Preparations 72
C. Odor Results 72
D. Smoke Results 79
E. Summary 81

VI. EMISSIONS FROM A VARIETY OF DIESEL TRUCKS 82

A. Emissions from 1967 Ford 82
B. Emissions from 1964 GMC 84
C. Emissions from 1961 Mack 85
D. Emissions from 1969 International Harvester 87
E. Emissions from 1968 Ford 89
F. Emissions from 1965 White Freightliner 89
G. Summary 91

VII. VARIOUS DIESEL EMISSIONS MEASUREMENTS 93

A. Evaluation of Electrostatic Precipitator 93
B. Bureau of Mines - SwRI Odor Panel Cross Check 99
C. Effect of Fuel Type on Exhaust Odor 101
D. Effect of Injectors on Emissions 102

VIII. INVESTIGATION OF INSTRUMENTAL METHODS FOR ODOR MEASUREMENT . 112

A. Review of Part II Preliminary Study 112
B. Technique Development 112
C. Preliminary Correlation Results 124
D. Procedure Refinement 130
E. Eleven-Vehicle Correlation Study 132

IX. ODOR, SMOKE, AND OTHER EMISSIONS FROM AN INTERCITY COACH 141

A. Objective 141
B. Vehicle Description 141
C. Results 141

X. SUMMARY 146

XI. RECOMMENDATIONS 148

LIST OF REFERENCES 150

APPENDIXES 151

LIST OF ILLUSTRATIONS

Figure		Page
1	U.S. Public Health Service Quality/Intensity Kit for Characterization and Evaluation of Diesel Exhaust Odor	5
2	U.S. Public Health Service Full-Flow Light-Extinction Smokemeter	5
3	Isometric View of Odor Facility	6
4	Odor Panel and Exposure Facility for Simultaneous Evaluation of Diluted Sample Odor Quality/Intensity	7
5	Special SwRI Laboratory Road Simulation Facility	8
6	Special SwRI Chassis Dynamometer and Vehicle Inertia Simulation Equipment	8
7	U.S. Public Health Service Smokemeter Mounted on Extended GM Municipal Bus Exhaust Pipe	9
8	Truck-Tractor Prepared for Smoke and Odor Evaluations	9
9	Truck-Tractor Prepared for Smoke and Odor Evaluations	10
10	Array of Nondispersive Infrared, Nondispersive Ultraviolet and Polarographic Analyzers	11
11	High-Temperature Hydrocarbon Analyzer Sample Handling and Detector	11
12	High-Temperature Hydrocarbon Analyzer Sample Handling and Detector	12
13	High-Temperature Hydrocarbon Analyzer Electrometer Readout and Range Control	12
14	Sampling of Diesel Exhaust for Wet Chemical Analyses	13
15	Analysis of Wet Collected Samples of Diesel Exhaust for Aldehydes, Acrolein, Sulfur Dioxide, and Nitrogen Oxide	13
16	Dual Column Gas-Liquid Chromatograph Used in Odor Chemistry Studies	14
17	Overall Comparison of Diesel Odor Evaluation of a No. 1 Diesel Fuel With and Without Additive A	18
18	Overall Comparison of Diesel Odor Evaluation of a No. 1 Diesel Fuel With and Without Additive B	19
19	Overall Comparison of Diesel Odor Evaluation of a No. 1 Diesel Fuel With and Without Additive C	19
20	Overall Comparison of Diesel Odor Evaluation of a No. 1 Diesel Fuel With and Without Additive D	20
21	Code "Z" Catalytic Muffler General Configuration	33
22	Code "Z"-1 Catalytic Muffler Before and After Test	34
23	Code "Z"-2 Catalytic Muffler Before and After Test	35

LIST OF ILLUSTRATIONS (Cont'd)

Figure Page

24 Code "W" Catalytic Muffler . . . 36

25 Overall Comparison of Diesel Odor Evaluation With and Without Catalytic Muffler Installed . . . 38

26 Overall Comparison of Diesel Odor Evaluation With and Without Catalytic Muffler Installed . . . 38

27 Code "W" Catalytic Muffler Test Configuration . . . 40

28 Overall Comparison of Diesel Odor Evaluation With and Without Catalytic Muffler Installed . . . 42

29 Catalytic Muffler Code "V" . . . 44

30 Installation of Code "V" Catalytic Muffler Under GM Model TDH 4519 Coach . . . 45

31 Installation of Code "V" Catalytic Reactor Serving Rear Bank of Engine . . . 45

32 Experimental Catalytic Muffler Code "U" . . . 46

33 Code "T" Catalytic Muffler . . . 46

34 Overall Comparison of Diesel Odor Evaluation With and Without Code "V" Catalytic Muffler Installed . . . 49

35 Overall Comparison of Diesel Odor Evaluation With and Without Code "U" Catalytic Muffler Installed . . . 51

36 Code "W" Catalytic Muffler Installed in City Bus . . . 52

37 Performance of Code "W" Catalytic Mufflers on Exhaust Odor 20 mph - 40 hp Cruise . . . 55

38 Performance of Code "W" Catalytic Mufflers on Exhaust Odor 30 mph - 40 hp Cruise . . . 56

39 Performance of Code "W" Catalytic Mufflers on Exhaust Odor 40 mph - 40 hp Cruise . . . 56

40 Performance of Code "W" Catalytic Mufflers on Exhaust Odor Idle . . . 57

41 Performance of Code "W" Catalytic Mufflers on Exhaust Odor Idle-Acceleration . . . 57

42 Performance of Code "W" Catalytic Mufflers on Exhaust Odor Deceleration . . . 58

43 Comparison of "D" Odor Ratings from Ten E and Ten N Detroit Diesel 6V-71 Powered Municipal Buses . . . 75

44 Comparison of "B" Odor Ratings from Ten E and Ten N Detroit Diesel 6V-71 Powered Municipal Buses . . . 75

45 Comparison of "O" Odor Ratings from Ten E and Ten N Detroit Diesel 6V-71 Powered Municipal Buses . . . 76

LIST OF ILLUSTATIONS (Cont'd)

Figure | Page

46 Comparison of "A" Odor Ratings from Ten E and Ten N Detroit Diesel 6V-71 Powered Municipal Buses 76

47 Comparison of "O" Odor Ratings from Ten E and Ten N Detroit Diesel 6V-71 Powered Municipal Buses 77

48 Interaction Effect (Odor) Between the 20-mph, 40-hp Cruise and Decel Conditions for Buses Powered by E and N Type Engines 78

49 Lack of Interaction Effect (Smoke) Between the 20-mph Max Power and "After Upshift" Data for Buses Powered by E and N Type Engines 81

50 Single-Axle Truck-Tractor Prepared for Test 86

51 Single-Axle Truck-Tractor Under Dynamometer Test 86

52 Exterior of Gourdine EGD Diesel Precipitator Assembly 93

53 Schematic of Test Apparatus Used for Baseline Smoke Measurement 94

54 Schematic of Test Apparatus Used for Evaluation of Gourdine EGD Diesel Precipitator 94

55 Schematic of Resistor Pack and Ionizer 97

56 Gas Inlet Side of Ionizer Section of Gourdine EGD Diesel Precipitator in As- Received Condition, Showing Insulator Posts and Interior Surfaces 97

57 Gas Discharge Side of Ionizer Section of Gourdine EGD Diesel Precipitator in As-Received Condition, Showing Ionizer Wires, Supports, and Connectors 98

58 Gas Inlet Side of Ionizer/Attractor Assembly of Gourdine EGD Diesel Precipitator Showing Carbon Deposits After 46 Minutes of Engine Operation 98

59 Size 60 N Unit Injector Used in 71 Series Two-Cycle Detroit Diesel Engines 103

60 Cutaways of Standard and Needle Valve Unit Injector Spray Tips Used in Two-Cycle Engines 103

61 Comparison of Odor Ratings from 6V-71 E Powered Bus 677 Equipped With New "N" and Experimental ("X") Injectors 106

62 Comparison of Odor Ratings from 6V-71 E Powered Bus 681 Equipped With Used "S" and New "N" Type Injectors 109

63 Overall Comparison of Diesel Evaluation of 60S vs Low-Sac Injectors 110

64 Trap and Low Temperature Cold Bath for Removal of Diesel Exhaust Odor . . . 113

65 Gas Chromatogram of GMC 1-71 Exhaust Condensate at 1000 rpm and 8.5 hp 114

66 Gas Chromatogram of GMC -171 Exhaust Condensate at 1000 rpm and 0 hp 114

LIST OF ILLUSTRATIONS (Cont'd)

Figure		Page
67	Gas Chromatogram of GMC 1-71 Exhaust Condensate at Idle (500 rpm)	115
68	Diesel Exhaust Condensate Sampling Train	116
69	Cold Trap Systems to Remove and Collect Odor from Four Samples at the Same Time	116
70	Trap, Sample Transfer Needle and Syringe, Sample Vial and Injection Syringe	117
71	Gas Chromatogram of Bus 680 6V-71E Exhaust Condensate at Hot Idle and 40 mph--40 hp	119
72	Gas Chromatogram of Cummins NH-220 (Four-Cycle) and Bus 677 6V-71E (Two-Cycle) Exhaust Condensate at Hot Idle	120
73	Gas Chromatogram of Cummins NH-220 (Four-Cycle) and Bus 677 6V-71E (Two-Cycle) Exhaust Condensate at Power Conditions	121
74	Gas Chromatograms of Bus 683 6V-71 E and Cummins NH-220 Exhaust Condensate at Hot Idle	126
75	Gas Chromatograms of Bus 683 6V-71 E and Cummins NH-220 Exhaust Condensate at 20 mph--40 hp and 1500 rpm--125 hp, Respectively	127
76	Gas Chromatograms of Bus 683 6V-71 E and Cummins NH-220 Exhaust Condensate at 30 mph--40 hp and 1800 rpm--125 hp, Respectively	128
77	Gas Chromatograms of Bus 683 6V-71 E and Cummins NH-220 Exhaust Condensate at 40 mph--40 hp and 2100 rpm--125 hp, Respectively	129
78	Gas Chromatograms of Bus 683 6V-71 E Exhaust Condensate at Hot Idle (Catalytic Muffler)--Trapped from Individual Bags	132
79	Gas Chromatograms of Bus 683 6V-71 E Exhaust Condensate at Hot Idle (Stock Muffler)--Trapped from Individual Bags	133
80	Laboratory Test of an Intercity Bus	142
81	Intercity Bus Prepared for Odor and Other Emissions Measurements	142
82	Intercity Bus Engine Compartment	143
83	Intercity Bus Engine Compartment	143

LIST OF TABLES

Table		Page
1	Commercial Diesel Fuel Specifications - Typical	15
2	Inspection of Commercial No. 1 and No. 2 Diesel Fuels Used in Part III Program	15
3	Overall Summary of Odor Evaluations Additive-Treated vs Untreated No. 1 Diesel Fuel	17
4	Overall Summary of Odor Evaluations Selection of Most Representative Baseline Operation for Comparison of Additive-Treated Fuels	22
5	Inspection Data for No. 1 Kerosene Type Commercial Diesel Fuel Used During Fleet Test of Odor Additive	23
6	Overall Summary of Odor Evaluations, Additive-Treated Fuel vs Untreated Base Fuel	25
7	Overall Summary of Smoke Evaluations, Additive-Treated Fuel vs Untreated Base Fuel	26
8	Summary of Average "As-Measured" Exhaust Emissions Measurements Additive-Treated Fuel vs Untreated Base Fuel	26
9	Overall Summary of Odor Evaluations, Additive-Treated Fuel vs Untreated Base Fuel	27
10	Overall Summary of Smoke Evaluations, Additive-Treated Fuel vs Untreated Base Fuel	28
11	Summary of Average "As-Measured" Exhaust Emissions Measurements Additive-Treated Fuel vs Untreated Base Fuel	28
12	Overall Summary of Odor Evaluations, Additive-Treated Fuel vs Untreated Base Fuel	29
13	Overall Summary of Smoke Evaluations, Additive-Treated Fuel vs Untreated Base Fuel	30
14	Summary of Average "As-Measured" Exhaust Emissions Measurements Additive-Treated Fuel vs Untreated Base Fuel	31
15	Effect of Additive Dose Level on Perceived Odor	31
16	Effect of Additive Base Level on Sample	32
17	Overall Summary of Odor Evaluation Catalytic Muffler Code "Z" vs Stock Muffler	37
18	Comparison of Smoke from Catalytic Muffler Code "Z" vs Stock Muffler	39
19	Summary of Exhaust Emissions and Muffler Pressure and Temperature Measurements Catalytic Muffler Code "Z" vs Stock Muffler	40
20	Overall Summary of Odor Evaluation Catalytic Muffler Code "W" vs Stock Muffler	41

LIST OF TABLES (Cont'd)

Table		Page
21	Comparison of Smoke from Catalytic Muffler Code "W" vs Stock Muffler	43
22	Summary of Exhaust Emissions and Muffler Pressure and Temperature Measurements	43
23	Comparison of Odor Panel Responses for Catalytic Muffler Code "V" and Stock Muffler	47
24	Comparison of Smoke from Catalytic Muffler Code "V" and Stock Muffler	48
25	Exhaust Emissions Summary, Catalytic Muffler Code "V" and Stock Muffler	48
26	Comparison of Odor Panel Responses for Catalytic Muffler Code "U" and Stock Muffler	50
27	Comparison of Smoke from Catalytic Muffler Code "U" and Stock Muffler	50
28	Exhaust Emission Summary, Catalytic Muffler Code "U" and Stock Muffler	51
29	Vehicle 677 Schedule of Catalytic Muffler Code "W"-1 Evaluations	53
30	Vehicle 679 Schedule of Catalytic Muffler Code "W"-2 Evaluations	54
31	Vehicle 681 Schedule of Catalytic Muffler Code "W"-3 Evaluations	54
32	Overall Summary of Odor Evaluations Catalytic Muffler "W"-1 vs Stock Muffler	59
33	Comparison of Smoke from Catalytic Muffler Code"W"-1 vs Stock Muffler	60
34	Overall Summary of Exhaust Emissions Measurements and U_s Analysis Catalytic Muffler Code "W"-1 vs Stock Muffler	61
35	Muffler Pressure and Temperature Summary Catalytic Muffler Code "W"-1 vs Stock Muffler	62
36	Overall Summary of Odor Evaluations Catalytic Muffler "W"-2 vs Stock Muffler	63
37	Comparison of Smoke from Catalytic Muffler Code "W"-2 vs Stock Muffler	64
38	Overall Summary of Exhaust Emissions Measurements and U_s Analysis Catalytic Muffler Code "W"-2 vs Stock Muffler	65
39	Muffler Pressure and Temperature Summary Catalytic Muffler Code "W"-2 Stock Muffler	66
40	Overall Summary of Odor Evaluations Catalytic Muffler "W"-3 vs Stock Muffler	67

LIST OF TABLES (Cont'd.)

Table		Page
41	Comparison of Smoke from Catalytic Muffler Code "W"-3 vs Stock Muffler	68
42	Overall Summary of Exhaust Emissions Measurements and U_s Analysis Catalytic Muffler Code "W"-3 vs Stock Muffler	69
43	Muffler Pressure and Temperature Summary Catalytic Muffler Code "W"-3 vs Stock Muffler	70
44	Summary of Ten Bus Odor Ratings	73
45	Summary of Ten Bus Odor Ratings	73
46	Comparison Exhaust Odor Ratings for Ten E and Ten N Detroit Diesel 6V-71 Powered Municipal Buses	74
47	Summary of Ten Bus Smoke Ratings	79
48	Summary of Ten Bus Smoke Ratings	79
49	Comparison of Exhaust Smoke Ratings for Ten E and N Detroit Diesel 6V-71 Powered Municipal Buses	80
50	Ranking of Ten N Powered Municipal Buses by Average Smoke Output; High to Low	80
51	Odor and Smoke Summary	83
52	Exhaust Emissions Summary	83
53	Odor and Smoke Summary	84
54	Exhaust Emissions Summary	85
55	Odor and Smoke Summary	87
56	Exhaust Emissions Summary	88
57	Odor and Smoke Summary	88
58	Exhaust Emissions Summary	89
59	Odor and Smoke Summary	90
60	Exhaust Emissions Summary	90
61	Odor and Smoke Summary	91
62	Exhaust Emissions Summary	92
63	Gourdine EGD Ionizer Current as a Function of Ionizer Voltage	95
64	Smoke Data With and Without the Gourdine EGD Precipitator Operative	96
65	Comparison of Panel Ratings at 100:1 Dilution Level, Two-Cycle Exhaust	99

LIST OF TABLES (Cont'd)

Table Page

66 Comparison of Panel Ratings at 100:1 Dilution Level, Four-Cycle Exhaust 100

67 Performance of Panels at Two Different Dilution Ratios 101

68 Comparison of Odor Panel Responses for No. 1 vs No. 2 Diesel Fuel 102

69 Comparison of Odor Panel Response for 60N vs 60X Type Injectors 104

70 Comparison of Smoke Readings for 60N Injectors vs 60X Injectors 105

71 Summary of Exhaust Emissions Measurements and U_s Statistical Analysis - 60N vs 60X Injectors 105

72 Comparison of Odor Panel Responses fro 60S Injectors vs 60N Experimental Injectors 107

73 Comparison of Smoke Readings for 60S Injectors vs 60N Experimental Injectors 108

74 Summary of Exhaust Emissions Measurements and U_s Statistical Analysis - 60S vs 60N Injectors 108

75 Comparison of Odor Panel Responses for 60S Injectors vs Low-Sac Injectors 110

76 Comparison of Smoke Readings for 60S Injectors vs Low-Sac Injectors 111

77 Summary of Exhaust Emissions Measurements and U_s Statistical Analysis 60S vs Experimental Low-Sac Injectors 111

78 Comparative Relative Retention Ratios of Exhaust Condensate Components of Four-Cycle and Two-Cycle Engines 122

79 Mass Spectral Analysis of Exhaust Condensate 122

80 Retention Times of Selected Compounds Found in Exhaust Odor Condensate 123

81 Comparison of Odor Panel Responses for Cummins NH-220 Engine and Detroit Diesel 6V-71 Engine 125

82 Summary of Exhaust Emissions Measurements and U_s Statistical Analysis Cummins NH-220 Engine and Detroit Diesel 6V-71 Engine 125

83 Statistical Correlation Study of Diesel Odor and Emissions List of Variables, Their Mean and Standard Deviation 130

84 Exhaust Condensate Sample Recovery Data 131

85 Description of the Eleven Engines/Vehicles Used in Correlation Study 134

86 Overall Summary of Emissions Measurements for Eleven-Vehicle Correlation 134

87 Overall Summary of Odor Ratings for Eleven-Vehicle Correlation 135

LIST OF TABLES (Cont'd)

Table		Page
88	Statistical Correlation Study of Diesel Odor and Emissions Lists of Variables, Their Mean and Standard Deviation to Several Correlation Methods	136
89	Correlation Equations--Eleven-Vehicle Study	137
90	Effect of Correlated Variables of the DBOAP Intensity Rating (Based on Mean Values)	138
91	Correlation Comparison with All Variables and Total Hydrocarbons Only	139
92	Overall Summary of Odor Evaluation of Intercity Buses Average Odor Panel Response	144
93	Overall Summary of Smoke Readings from Intercity Buses	144
94	Overall Summary of Exhaust Emissions from Intercity Buses	145

I. INTRODUCTION

Emissions from diesel-powered vehicles continue to be the object of increased government and industrial concern. A long-range investigation of diesel-powered vehicle odor and smoke, sponsored by the National Air Pollution Control Administration, began at Southwest Research Institute's Vehicle Emissions Research Laboratory in February 1966. Part I of this long-range investigation was completed in February 1967. The Southwest Research Institute diesel studies were part of the overall Public Health Service program and were coordinated with those underway by the U.S. Bureau of Mines, and at several other research laboratories. Prior to introducing the objective and approach of the Part III work, it may be helpful to briefly review the Part I and II program and results.

A. Review of the Part I Project

The initial year of program effort, completed in February 1967, was concerned with noticeable levels of diesel smoke and odor both from two-cycle powered city buses and four-cycle powered intercity trucks. The program included field studies, development of facilities and procedures, study of vehicle variability, and investigation of two techniques for smoke reduction. The field studies were conducted to determine: (1) operating conditions that produce significant levels of odor and smoke, and (2) the level of atmospheric exhaust dilution that a motorist or pedestrian might experience behind a bus or truck. Results of the field studies indicated that the two-cycle powered bus odor and smoke were grossly different from the four-cycle powered truck. Reasonable atmospheric dilution levels from a typical horizontal bus exhaust were found to range from 100:1 to 1000:1, whereas the dilution levels from a vertical exhaust stack equipped truck ranged from 700:1 to 7000:1.

These results permitted realistic simulation of field operation in a specially designed laboratory odor and smoke measurement facility. Newly developed Public Health Service smoke and odor measurement methods were employed in this facility. The odor measurement method involved simultaneous exposure of a panel of ten persons to a diluted sample of diesel exhaust. A diesel odor evaluation kit, composed of an overall diesel odor and four different qualities at various intensities, was used as a reference by the panel. Smoke was measured by means of a PHS smokemeter under both constant speed and accelerating type vehicle conditions. Utilizing these measurement methods, chassis dynamometer, panel, and smokemeter procedures were developed for the city bus and for the intercity tractor.

These conditions and procedures were then employed to measure the smoke and odor variability from ten similar buses and ten similar trucks. Limited investigations of fumigation and dilution (two proposed methods for reducing smoke) resulted in only a partial or technical success. For complete results and discussion of the Part I studies, please refer to the comprehensive final technical report entitled "An Investigation of Diesel Powered Vehicle Odor and Smoke - Part I" (Ref. 1)* dated March 1967 under Contract PH 86-66-93. A brief summary of the preparations phase for the Part I program as well as program objectives may be found in a paper presented at the National Petroleum Refiners Fuels and Lubricants Meeting in Philadelphia in September 1967 (Ref. 2).

B. Review of the Part II Project

Continuing Part I of the long-range investigation of diesel-powered vehicle odor and smoke, the Part II program was concerned with the effectiveness of various methods of reduction and control of diesel emissions. To this end, the diesel emissions measurement facilities, procedures, and conditions established, developed and identified during the Part I program were employed. An evaluation of several two-cycle powered municipal buses equipped with automotive type catalytic devices revealed that one device noticeably reduced exhaust odor and certain other emissions such as formaldehyde, total aldehydes, and acrolein. Although the catalytic device had no positive effect on smoke, it did possess an excessive sound level in the single configuration evaluated.

A 6-month evaluation of the smoke suppressing ability of a commercially available barium diesel fuel additive in a five-truck fleet was successful in demonstrating the effectiveness of this technique for smoke reduction over an extended period. Engine derating was investigated for its effect on exhaust odor and smoke with a Cummins NH-220 and GM 6-71 N, and a Mack END-673P. Although engine power rating was found to have a pronounced effect on visible smoke output, power rating appeared to have little or no effect on perceived odor. A limited study of the effect of injecting air in the exhaust at the underside of exhaust valves of a two-cycle powered municipal bus had a negligible effect on odor and smoke. A brief evaluation of the effect of the Jacobs engine brake on the odor and smoke from another two-cycle powered bus also resulted in no noticeable change. A variety of small evaluations and special studies were conducted and reported, including the effect of exhaust pipe size on smoke readings, preliminary studies of a tentative PHS smoke procedure, attempted evaluation of an electrostatic precipitator, and base line odor, smoke, and emissions from a municipal coach powered by a four-cycle V8 engine. The results of a preliminary feasibility study and experimental evaluation of an instrumental method for possible diesel odor rating and correlation to the human odor panel method were reported.

---

*A complete list of references may be found at the conclusion of the text of this report.

For complete description and results of the Part II project, refer to the final report entitled "An Investigation of Diesel Powered Vehicle Odor and Smoke - Part II" (Ref. 3) dated February 1968 under Contract PH 86-67-72. The highlights of the Part I and Part II projects were included in a paper presented to the Society of Automotive Engineers Mid-Year Meeting in Detroit in May 1968 (Ref. 4).

C. Objective and Approach

The objective of the Part III project was to continue to provide assistance to the National Air Pollution Control Administration in the development of engineering data regarding emissions from diesel-powered vehicles. As in previous parts of this long-range project, Part III consisted of a number of phases, each almost a study of its own. These studies or study areas were as follows:

- Fleet Test of a Diesel Fuel Odor Additive
- Fleet Test of Catalytic Muffler
- Bus Odor and Smoke Variability
- Emissions from a Variety of Diesel Trucks
- Various Diesel Emissions Measurements
- Instrumental Methods for Odor Measurements
- Odor, Smoke, and Other Emissions from an Intercity Coach.

The fleet tests had the objective of determining the performance and cost effectiveness of odor control methods. The objectives of other phases such as Bus Odor and Smoke Variability, Emissions from a Variety of Diesel Trucks, and Odor, Smoke, and Other Emissions from an Intercity Coach were to learn more about the odor, smoke, and other exhaust emissions from vehicles heretofore not studied. The various category included studies of new ways to reduce diesel emissions.

As in previous portions of this study, the overall approach was the same; determine diesel emissions using the PHS developed odor and smoke measurement methods and the latest chemical analyses techniques. The vehicles (engines) were to be operated under a variety of road like conditions conducive to the production of noticeable levels of odor and smoke. For control device evaluation, the approach was to operate on a back-to-back basis with and without the control device operative or with and without additive treated base fuel. This fair and impartial approach was most successful in these evaluations. Correlation studies of exhaust constituents to the human panel odor ratings made use of simultaneous analysis by both the instruments and odor panel. This approach, involving four replications of each condition in random, helped to insure statistical validity of results.

D. Participation in Coordinating Research Council Activities

In conjunction with this long-range investigation of diesel-powered vehicle odor and smoke, Vehicle Emissions Research Laboratory staff have been active in various groups and panels of the Coordinating Research Council (CRC). As a participant in the cross-check of diesel hydrocarbon measurement, a newly developed flame ionization method was employed. Another cooperative project, a cross-check of full-flow light-extinction smokemeters (similar to the PHS meter) by means of calibrated neutral density filters, is in progress. This cross-check is being coordinated by SwRI. Active participation in the CRC Odor Panel emphasizes the importance of the SwRI diesel odor measurement background. These and several other areas will be covered at the CRC diesel emissions symposium at the

Blackstone Hotel, Chicago, October 27 and 28, 1969. Much of the experience to be reported on and shared with others will be a direct result of the long-range investigation.

E. Presentation of Technical Papers

Two technical papers were offered to national engineering societies dealing with emissions from diesel powered vehicles. The papers are described below:

Society	Meeting	Title	Author
American Society of Mechanical Engineers	Winter Annual Meeting in Los Angeles, November 1969	Four Years of Diesel Odor and Smoke Control Technology - A Summary	Karl J. Springer Charles T. Hare
Society of Automotive Engineers	Winter Annual Meeting in Detroit, January 1970	Diesel Exhaust Hydrocarbon Measurement - a Flame Ionization Method	Karl J. Springer Harry E. Dietzmann

The ASME paper (Ref. 5) describes the highlights of the first three parts of the long-range investigation of diesel odor and smoke. The paper offered to the Society of Automotive Engineers (Ref. 6) describes the special diesel hydrocarbon analyzer, its development, and its application.

F. Diesel Odor Contractors Workshop

Two representatives of the Vehicle Emissions Research Laboratory participated in the June 11-12, 1969, workshop meeting of the PHS contractors engaged in diesel odor research. Two 30-min prepared presentations were given, one on the odor correlation studies described later in this report and the other on the acquisition of public opinion of diesel odor. The correlation studies involved instrumental and chemical measurements with the objective of extending the usefulness of the trained odor panel.

II. DESCRIPTION OF FACILITY, EQUIPMENT, AND FUELS

Studies of diesel exhaust emissions such as smoke, various chemical constituents, and particularly odor have been seriously restricted by the lack of specialized facilities, equipments, and instruments required for their measurement. One of the major objectives of the Part I program was to develop special facilities and systems to permit a realistic and repeatable measurement of diesel exhaust odor and smoke. Prior to the introduction of the full-flow, light-extinction type smokemeter and the concept of a subjective qualitative-quantitative characterization of exhaust odor by a trained human panel, suitable or satisfactory measurement methods for diesel odor and visible smoke were virtually nonexistent. The remainder of this section, broken into three subsections, covers: the SwRI diesel exhaust emissions facility; support equipment, instruments, and apparatus; and a description of the fuels utilized.

A. Diesel Emissions Measurement Facility

The Part III investigation was intended to apply the odor and smoke measurement methods and know-how to establish effectiveness of various diesel emissions control techniques. To accomplish this objective, the SwRI Vehicle Emissions Laboratory facilities were needed to simulate road conditions for the primary test items, diesel-powered buses and trucks, as well as for the presentation and evaluation of dilute diesel exhaust odor via the SwRI odor panel. Availability of representative, two-cycle and four-cycle exhaust was also necessary from test bed operated, single and multicylinder diesel engines. Briefly reviewed and discussed in this subsection are the odor and smoke measurement methods and facilities developed during the Part I and II studies and utilized in this project.

1. Measurement Methods

Prior to the Part I program, the National Air Pollution Control Administration recognized the need for odor and smoke measurement methods that would relate to what people sensorily experience as diesel exhaust odor and smoke. Under the guidance of Dr. Amos Turk, a quality/intensity (Q/I) kit comprised of a diesel composite odor and four constituent qualities diluted to various concentrations or intensities was developed. This kit of synthetic diesel-like odor qualities and intensities formed the reference against which a trained odor panel judges and rates the dilute samples of diesel exhaust. (Refer to Ref. 7 for procedures and tests to select and train an odor panel for the evaluation of the quality and intensity of diesel exhaust.) This approach was intended to give an evaluation based on reproducible standards and was not intended as a means to ascertain levels of objectionability of diesel exhaust odor to the general public. Shown in Figure 1 is a photograph of the PHS diesel odor Q/I evaluation kit. In all, twenty-eight different odors or odor intensities are included in this kit: an overall diesel composite "D" ranging from "D"-1 to "D"-12 ("D"-12 the highest or most intense), a burnt-smoky quality "B," an aromatic-aldehydic quality "A," an oily quality "O," and a pungent quality "P," each ranging in intensity from 1 to 4, four representing the most intense. For details regarding the composition of the contents of each bottle standard, please see Reference 5.

Figure 2 is a photograph of the PHS smokemeter. The instrument measures and continuously indicates the density of the visible plume of vehicle exhaust. A light source is on one end of a collimating tube, and a photoelectric cell is located on the opposite end of the tube. The light source-collector cell assembly is placed either vertically over the usual 4-in.-diameter truck stack or horizontally behind the usual 3-in.-diameter city bus exhaust pipe so that the light beam traverses the smoke plume issuing from the stack or pipe. The percent opacity is then read remotely on a meter in the separate instrument cabinet. The meter, intended to correspond to what the public sees, is sensitive not only to the thickness of the smoke plume but the number of smoke particles per unit volume. During the course of the past year, a number of small but important changes were made to the PHS smokemeter. These refinements, all authorized by NAPCA (Ref. 8), were made to the smokemeter control unit so that voltage losses in the interconnecting cable could be minimized, photo cell loading optimized, and lamp voltage monitored. A three-pole, three-position switch was installed in the meter circuit. Position one is "off" and the meter is shorted, position two is meter calibration to 100-percent light transmittance (0-percent opacity), and position three permits monitoring the voltage to the lamp of the optical unit. All wiring was increased in size to No. 14 wire, with the exception of the photo cell output which was changed to a two-conductor, No. 22 gauge, shielded and grounded cable. A ten-turn 1k calibration potentiometer with locking dial was used instead of the single-turn calibration potentiometer to improve the meter to recorder adjustment. Changes in the circuitry were made to permit the 0- to 50-μA taut band output meter to be used as a 0- to 10-VDC voltmeter for monitoring the voltage input to the lamp. The lamp voltage was specified to be 6 VDC by this means. The

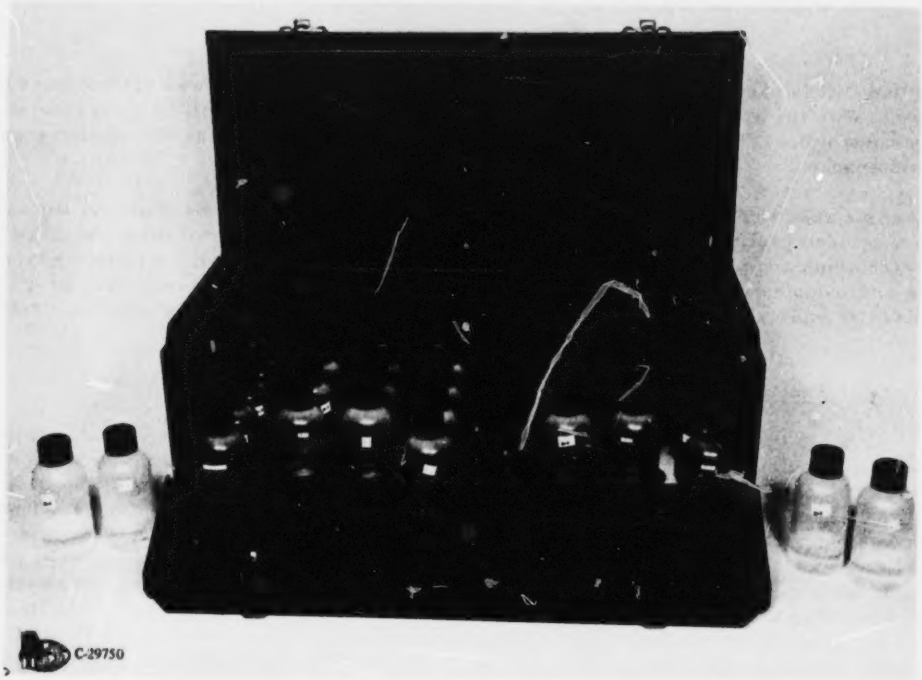


FIGURE 1. U.S. PUBLIC HEALTH SERVICE QUALITY/INTENSITY KIT FOR CHARACTERIZATION AND EVALUATION OF DIESEL EXHAUST ODOR

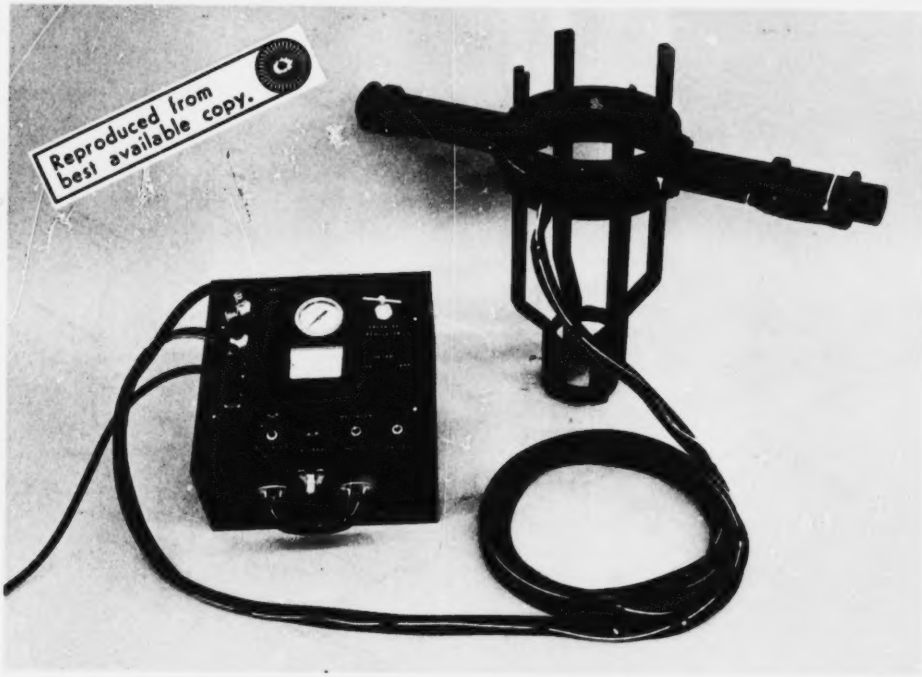

Reproduced from best available copy.

FIGURE 2. U.S. PUBLIC HEALTH SERVICE FULL-FLOW LIGHT-EXTINCTION SMOKEMETER

compact airline filter, normally used to remove water from the purge air, was discontinued by the manufacturer. With the approval of NAPCA officials, an improved filter will be used external to the smokemeter control box. This will minimize the removal of the control panel for draining water and periodic maintenance.

As a result of the revised circuitry and the refinements mentioned above, all authorized by NAPCA, a revised preliminary set of operating procedures were prepared (Ref. 9); these include mounting instructions and procedures for placing the smokemeter in service. Helpful hints on the maintenance and troubleshooting of the unit are also included. These procedures were prepared in lieu of official NAPCA publication and will be revised as experience dictates and as additional refinements are made.

2. Odor Facility

Although the odor and smoke measurement methods previously described represented a giant step forward in diesel emissions research, specialized facilities and techniques were necessary, especially to present proper samples of diesel exhaust for human panel evaluation. The design criteria to present simultaneously to a panel of ten people dilute samples of diesel exhaust under steady state cruise and transient acceleration-deceleration vehicle operation required the development of a wholly new approach in diesel odor measurement facilities. Figure 3, the overall isometric view of the odor facility, shows the general arrangement and layout of the exhaust sampling odor dilution system, and the method of handling and presenting the sample to each of the ten odor panelists. This figure also shows the close proximity of the test vehicle exhaust and chassis dynamometer road simulation equipment to the odor facility, odor room, dilution blower, etc. The sample system was designed and developed to automatically and continuously withdraw a constant mass of raw diesel exhaust regardless of temperature variation with minimum residence and hang-up (no moving parts), and without changing the character or composition of the exhaust. The raw diesel exhaust was continuously and rapidly mixed with prefiltered and deodorized (charcoal filtered) diluent air, and ducted immediately into the odor room for presentation to each of the panelists.

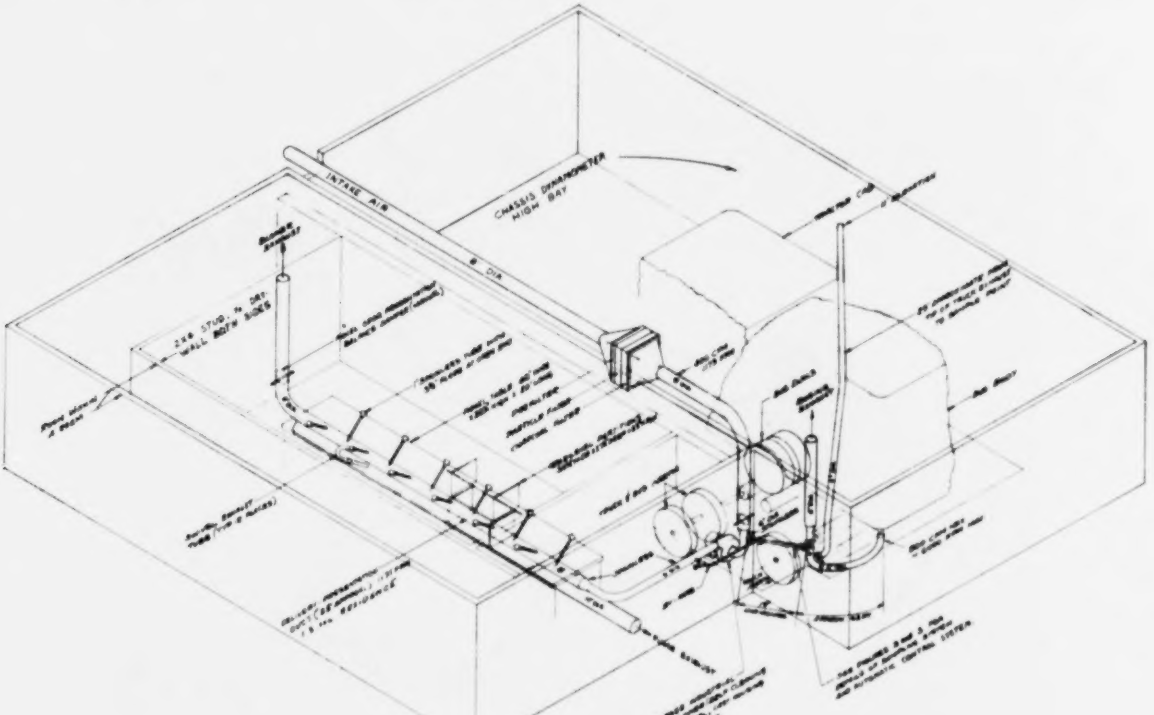


FIGURE 3. ISOMETRIC VIEW OF ODOR FACILITY

Not shown is a humidity control system, added during Part II, to maintain the dilution air at a constant 64 grains of water per pound of air at a dry bulb of 75°F.

Figure 4 illustrates the odor panel and exposure facility for a simultaneous evaluation of diluted samples of diesel exhaust. The odor panel, composed of ten housewives, evaluated the odor quality/intensity of the diluted sample, using the Q/I kit. Note the 1-in.-diameter tube which protrudes from the table top in the center of each cubicle. A portion, 1 cfm, of the diluted exhaust sample passed through this tube and out through the diffuser cone. When the panelist exposed her nose and nose area to the gas sample issuing from the diffuser, she rotated up, away from the diffuser, a larger cone connected to a fume removal system.

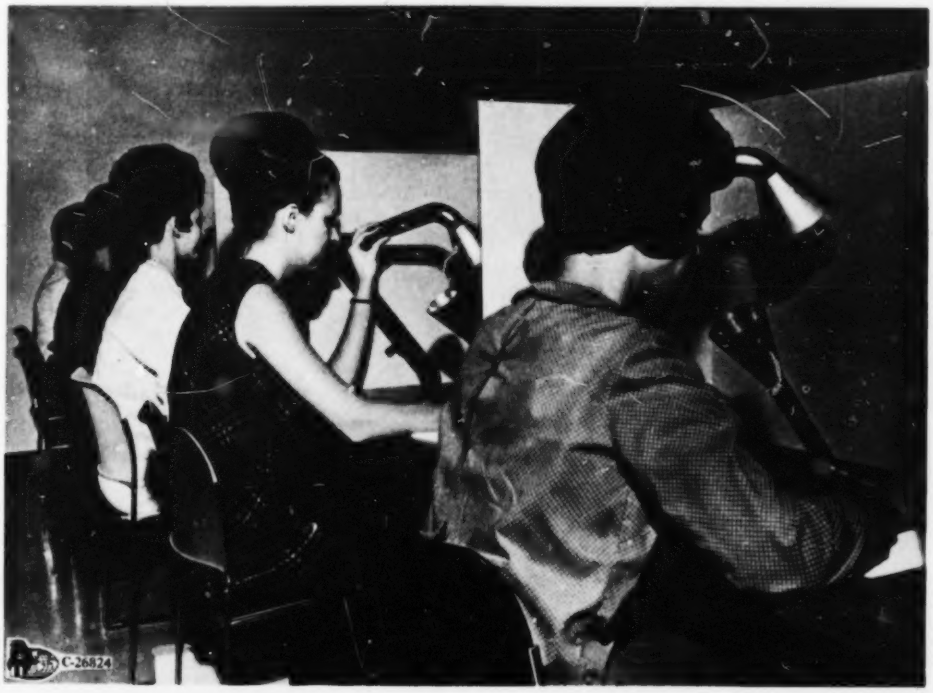


FIGURE 4. ODOR PANEL AND EXPOSURE FACILITY FOR SIMULTANEOUS EVALUATION OF DILUTED SAMPLE ODOR QUALITY/INTENSITY

To assure optimum panel performance, the major design criteria for the odor room were to maintain an environment as odor free as possible at a constant temperature and humidity, and operation of the vehicles on the road simulation equipment in the adjacent high bay area should not be apparent or recognizable to the panelists. These requirements dictated that a special odor panel "room within a room," shown in Figure 3, be designed and constructed. For additional description and design details, refer to References 1-4.

3. Laboratory Road Simulation Facility

The nature of the odor and smoke measurement techniques necessitated the use of a special road simulation facility. A modified Clayton chassis dynamometer (Model CTFF 200 X 200), capable of handling tandem axle drive truck-tractors and absorbing up to 200 hp from each axle, was employed. Figure 3 provides an overall view depicting the locations of the road simulation equipment relative to the odor facility--sampling, dilution, and odor room, etc. In addition to simulating on the chassis dynamometer road load and constant power conditions, it was desired to simulate vehicle acceleration under loaded and open-rack engine operation. To do so, large solid disc flywheels were directly connected to the absorber roll of the chassis dynamometer. Three wheels were used, two capable of simulating 16,000 lb of vehicle weight each and the third capable of simulating 8430 lb. These wheels were arranged to permit up to 24,430-lb vehicle weight inertia simulation from a single-drive axle bus and 32,000-lb vehicle inertia from tandem drive vehicles such as intercity trucks (16,000-lb vehicle weight simulation per axle). Figures 5 and 6 illustrate the SwRI tandem axle chassis dynamometer and vehicle inertia simulation facility. Figures 7 and 8 illustrate the installation of the PHS full-flow smokemeter on a municipal bus and a typical intercity cab-over truck-tractor. Note in Figure 7 that the 3-in. horizontal exhaust pipe is extended for mounting the smokemeter optical unit. The optical unit is mounted on the typical 4-in. truck exhaust stack as shown in Figure 8. The same tractor, prepared for odor evaluations, is shown in operation in Figure 9.

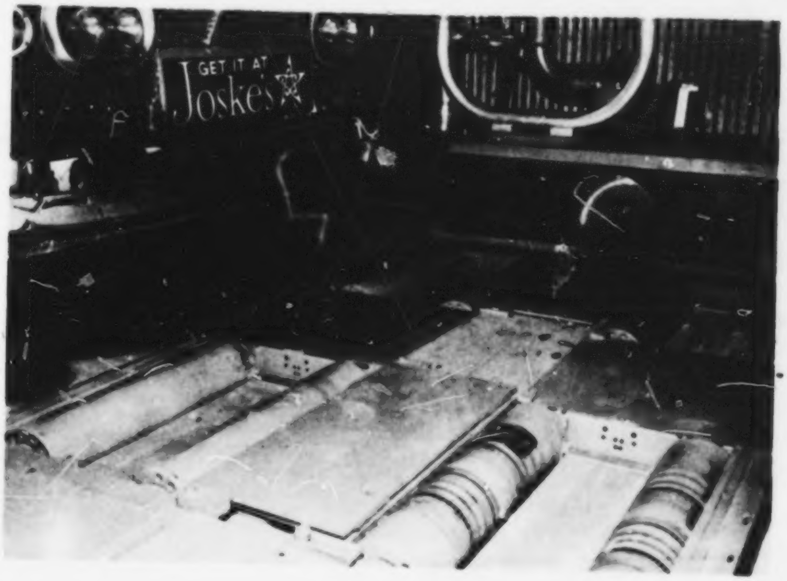


FIGURE 5. SPECIAL SwRI LABORATORY ROAD SIMULATION FACILITY

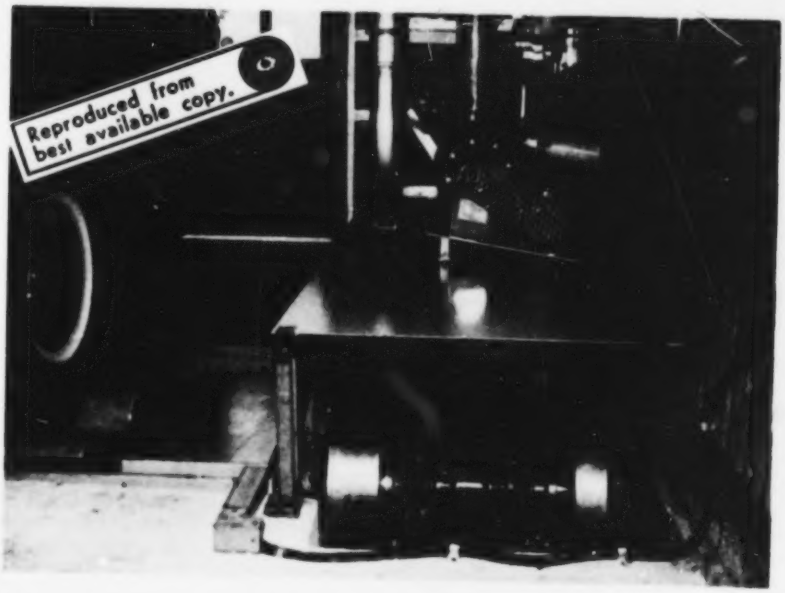

Reproduced from best available copy.

FIGURE 6. SPECIAL SwRI CHASSIS DYNAMOMETER AND VEHICLE INERTIA SIMULATION EQUIPMENT

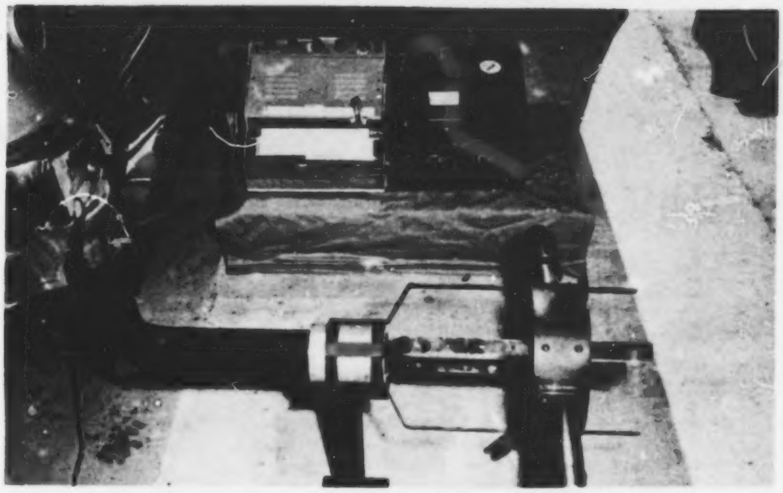
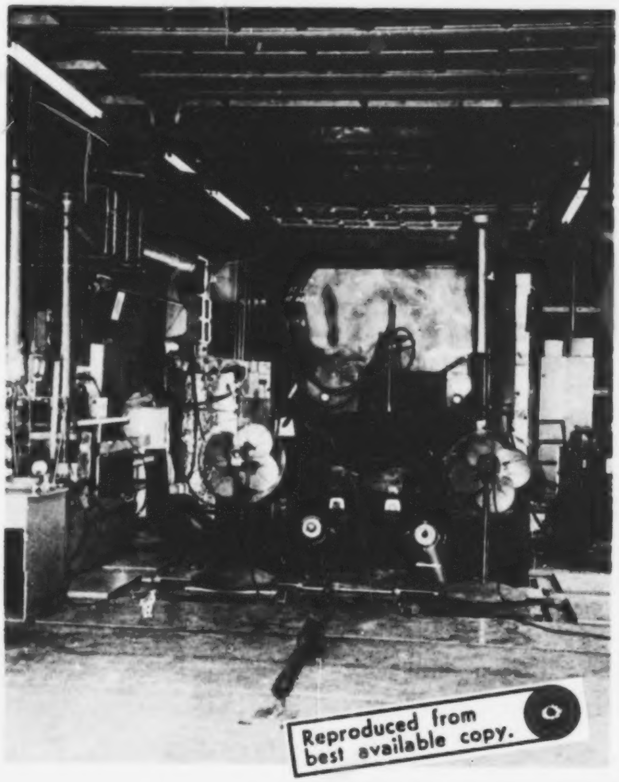


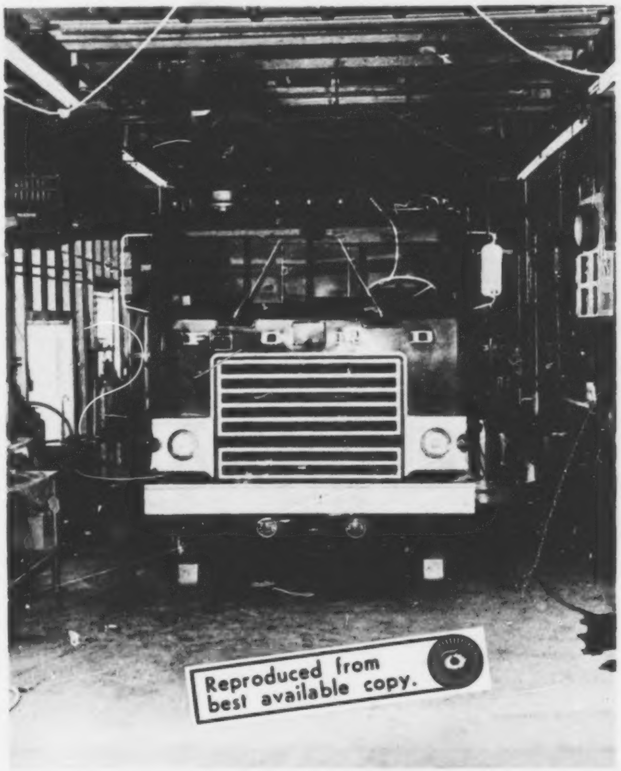
FIGURE 7. U.S. PUBLIC HEALTH SERVICE SMOKEMETER MOUNTED ON EXTENDED GM MUNICIPAL BUS EXHAUST PIPE



Reproduced from best available copy.

FIGURE 8. TRUCK-TRACTOR PREPARED FOR SMOKE AND ODOR EVALUATIONS

(Rear View)



Reproduced from best available copy.

FIGURE 9. TRUCK-TRACTOR PREPARED FOR SMOKE AND ODOR EVALUATIONS

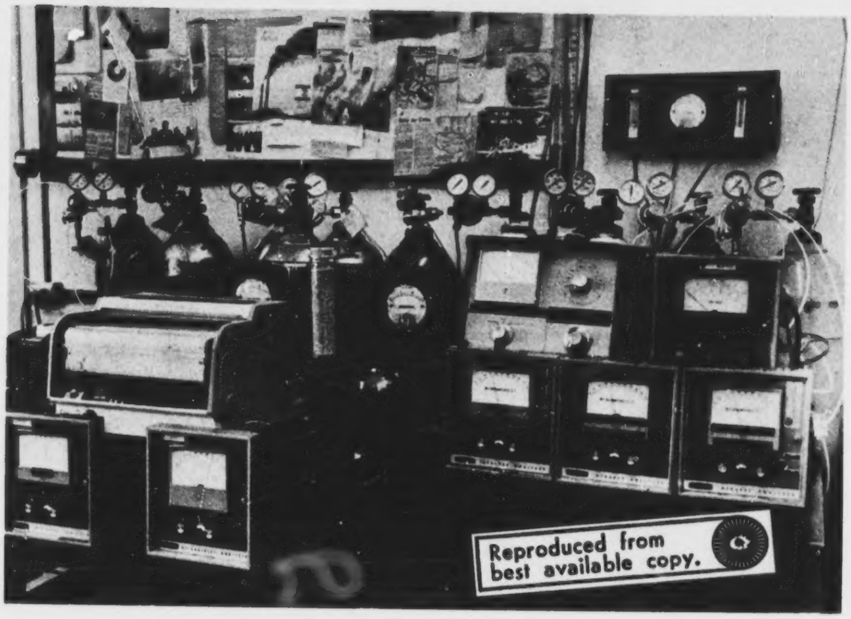
(Front View)

B. Equipment and Instruments

The Part III program utilized several new items of equipment which increased the capability for measuring diesel exhaust emissions. Shown in Figure 10 are the continuous monitoring instruments used for most of the instrumental analysis. Beckman Model 315 nondispersive infrared (NDIR) units were employed to measure 0- to 15-percent carbon dioxide (CO_2). and 0- to 2000-ppm carbon monoxide (CO). Oxygen was monitored by means of a Beckman polarographic analyzer. A dual range Beckman Model 315A NDIR was used to measure nitric oxide (NO), and another Beckman instrument, a nondispersive ultraviolet (NDUV) Model 315A was used to measure nitrogen dioxide (NO_2). The NO and NO_2 instrumentation was utilized as it became available, and complemented the NO_x measurements normally obtained by the modified Saltzmann method.

A high-temperature hydrocarbon analyzer was designed and developed to continuously monitor the total hydrocarbons in diesel exhaust. This new item of equipment made use of a Varian Model 600D gas chromatograph in which the sample was pumped under pressure to the flame ionization detector through a capillary restrictor. Figures 11, 12, and 13 are several views of the exterior, interior, and readout equipment. The sample is obtained from the hot exhaust pipe and maintained at 375°F with the pump, three-way valve, particulate filter, and flame ionization burner and detector, all located in an oven maintained at 375°F. For further description and details of this method, refer to the technical paper offered to the Society of Automotive Engineers (Ref. 6).

The analyses for acrolein, total aldehydes, formaldehyde, sulfur dioxide, and nitrogen oxides were by wet chemical techniques. These methods were described in detail with a number of references to the analytical procedures in the Part II chemistry studies (Ref. 3), and were used without change from the Part II program. Shown in Figures 14 and 15 are views of the sampling and analyses by these



Reproduced from best available copy.

FIGURE 10. ARRAY OF NONDISPERSIVE INFRARED, NONDISPERSIVE ULTRAVIOLET AND POLAROGRAPHIC ANALYZERS FOR CO, CO_2, O_2, NO AND NO_2

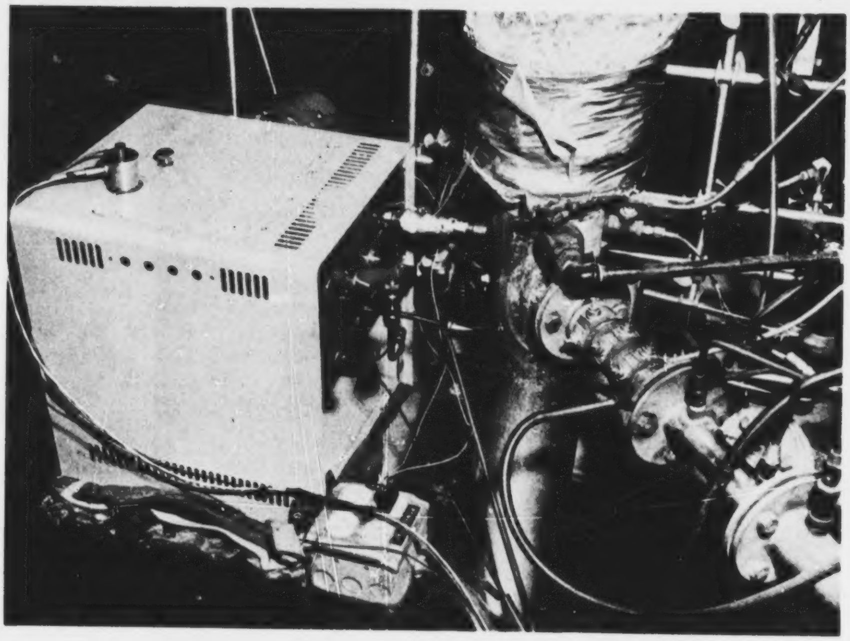


FIGURE 11. HIGH-TEMPERATURE HYDROCARBON ANALYZER SAMPLE HANDLING AND DETECTOR

(Exterior View)

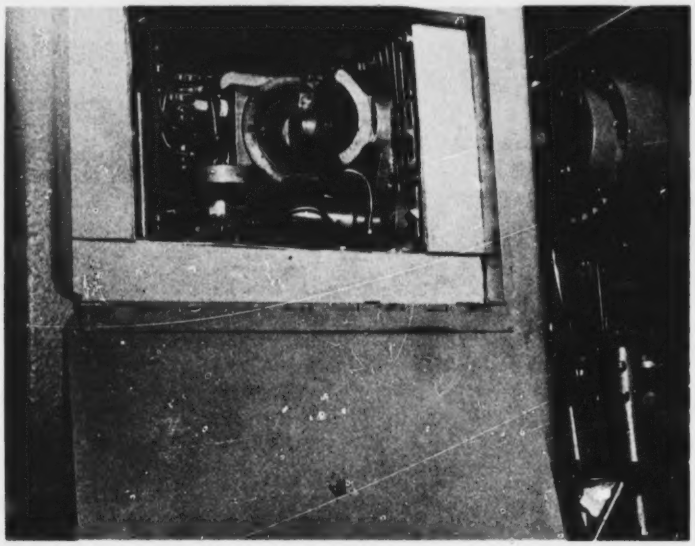
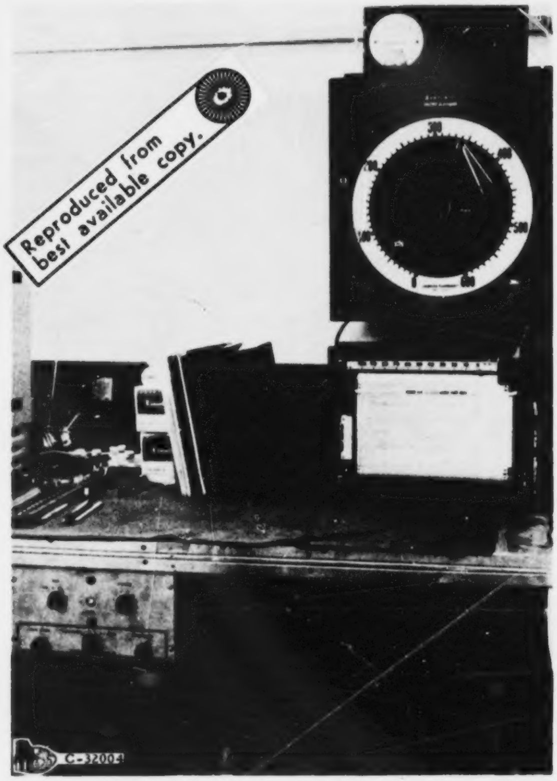


FIGURE 12. HIGH-TEMPERATURE HYDROCARBON ANALYZER SAMPLE HANDLING AND DETECTOR

(Interior View)



Reproduced from best available copy.

FIGURE 13. HIGH-TEMPERATURE HYDROCARBON ANALYZER ELECTROMETER READOUT AND RANGE CONTROL

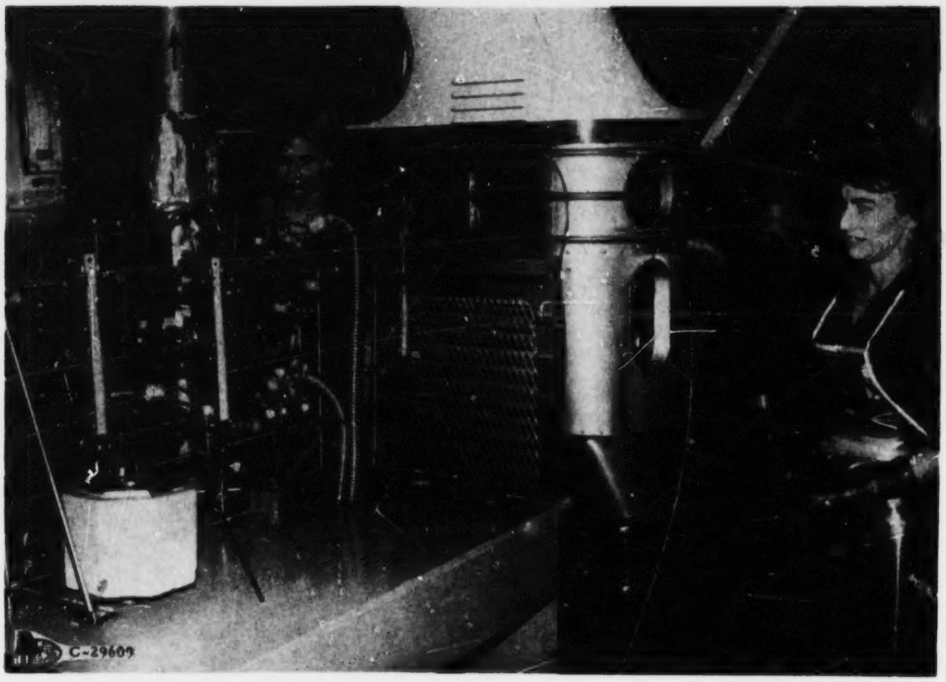


FIGURE 14. SAMPLING OF DIESEL EXHAUST FOR WET CHEMICAL ANALYSES

Reproduced from best available copy.

FIGURE 15. ANALYSIS OF WET COLLECTED SAMPLES OF DIESEL EXHAUST FOR ALDEHYDES, ACROLEIN, SULFUR DIOXIDE, AND NITROGEN OXIDE

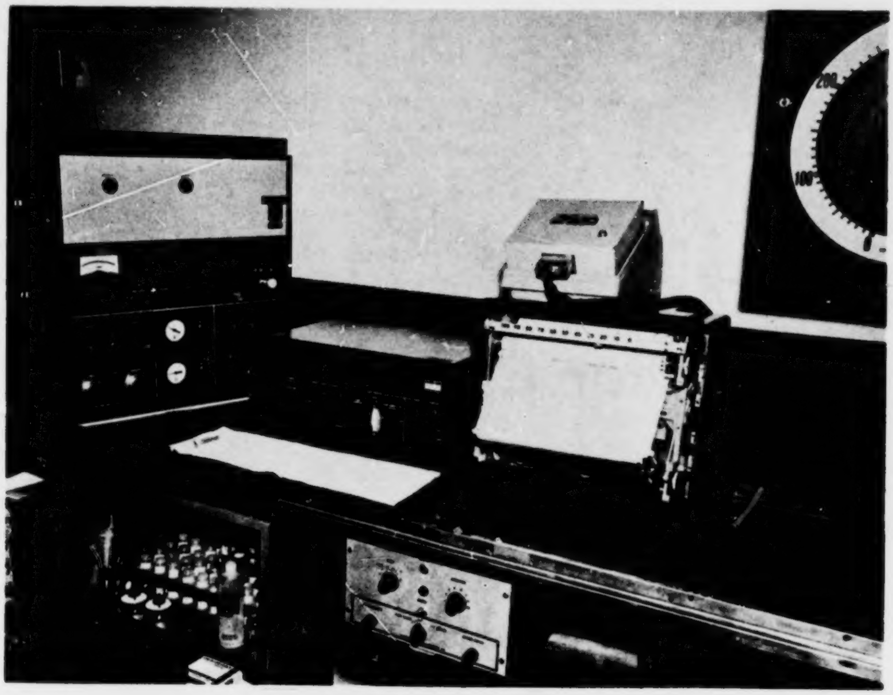


FIGURE 16. DUAL COLUMN GAS-LIQUID CHROMATOGRAPH USED IN ODOR CHEMISTRY STUDIES

wet methods. All of the chemical methods depended on a color change, which was measured by a Bausch and Lomb Spectronic 20. In addition to the Varian 600D gas-liquid chromatograph (GLC) previously used during odor correlation studies, a new Varian Model 1740 dual column chromatograph was procured and delivered in time for use with the latter portion of this project. This chromatograph is shown in Figure 16. The Institute Control Data Corporation CDC 3600 and CDC 6600 digital computers were employed during the statistical analysis of the odor, smoke, and emissions data.

C. Description of Fuels

This subsection covers the description of the No. 1 and No. 2 commercial type diesel fuels utilized during this program as well as typical specifications of fuels purchased by the San Antonio Transit System for municipal buses and the Ryder Truck System for intercity trucks. Listed in Table 1 are typical specifications of a No. 1 kerosene type fuel commonly utilized in municipal buses and of a No. 2 diesel fuel normally burned in intercity truck-tractor rigs. To eliminate the possible effect of diesel fuel type and composition on the odor, smoke, and other diesel exhaust emissions measurements, only known commercial No. 1 and No. 2 diesel fuels, stored in separate 1000-gal tanks, were consumed.

For the initial portion of the Part III program, the test fuels remaining from the Part II program were used. These fuels, EM-3A-F and EM-29-F, are described in Table 2 which lists pertinent inspection results such as distillation range, cetane number, sulfur content, aromatic, olefin and saturates composition. The inspection data for samples of these reference supplies indicate the distillation range to be slightly lower overall than the typical specifications of Table 1. The cetane number or ignition quality of both fuels was about 1 to 2 cetane numbers lower than the typical specification of 46 and 52 for No. 1 and 2 fuel. The greatest difference appeared to be the total sulfur content in EM-3A-F which was higher than the specification of Table 1. The sulfur values of the fuels used for reference, however, were not considered excessive.

On June 7, 1968, and February 3, 1969, additional 1000-gal supplies of No. 1 and No. 2 diesel fuel were obtained. These fuels were coded EM-70-F (No. 1 fuel) and EM-90-F (No. 2 fuel), and were purchased under the typical specifications listed in Table 1. The inspection reports are listed on Table 2. Inspection of the EM-70-F material revealed the boiling range to be identical to EM-3A-F. The sulfur content of 0.05 percent was essentially the same as the typical specification. The cetane number and the F.I.A. analysis (percent aromatics, olefins, and saturates) were about the same as other previously used No. 1 fuels. The boiling range, sulfur content, and gravity of the new supply of No. 2 diesel fuel, EM-90-F, were essentially the same as the previously used No. 2 fuel, EM-29-F. The cetane number was higher than previous and more in line with the No. 2 typical specification shown on Table 1. The aromatic content in the fuel was slightly greater than before with a few percent less saturates reported. Overall, the latest supplies of No. 1 and No. 2 diesel fuels compare favorably with those previously used in Part II. Also shown in Table 2 is the inspection of a sample of diesel fuel coded EM-73-F, which was typical of that used during the fleet test of the odor additive and catalytic muffler in six buses by the San Antonio Transit System. Untreated EM-73-F was used during the back-to-back evaluations of the performance of the odor additive.

TABLE 1. COMMERCIAL DIESEL FUEL SPECIFICATIONS - TYPICAL

Commercial Designation		1	2
Application		City Bus	Intercity Truck
Specification Provided by		S.A. Transit System	Ryder Leasing
Property	ASTM Test Method No.	Typical Specifications	
Cetane	D613	46	52
Pour Point, °F	D97	-60	-10
Flash Point, °F	D93	133	182
Gravity, °API			36.7
Viscosity, SUS at 100°F	D445 D446	32	35.5
Carbon Residue (10% Res), %	D189	0.07	0.03
Total Sulfur, %	D129	0.04	0.08
Alkali or Mineral Acids	D663 or D664	0.03	
Water and Sediment	D96	0	
Distillation Range	D86		
Initial Boiling Point, °F		350	392
10% Point, °F			444
50% Point, °F			516
90% Point, °F		465	574
End Point, °F		518	610

TABLE 2. INSPECTION OF COMMERCIAL NO. 1 AND NO. 2 DIESEL FUELS USED IN PART III PROGRAM

Commercial Fuel Type	1			2		
Sample Information Code Date Analyzed	EM-3-F(1) 1/27/67	EM-3A-F(2) 11/28/67	EM-70-F(3) 8/8/68	EM-73-F(4) 1/28/69	EM-29-F(5) 11/28/67	EM-90-F(6) 2/12/69
Property						
Distillation Range						
Initial Boiling Point, °F	326	340	338	336	352	365
10% Point, °F	360	360	364	364	414	418
20% Point, °F	372	372	372	371	441	439
30% Point, °F	380	380	380	384	460	460
40% Point, °F	388	389	387	394	476	475
50% Point, °F	396	398	395	402	491	490
60% Point, °F	404	405	404	410	504	503
70% Point, °F	414	415	412	418	519	517
80% Point, °F	428	429	427	430	536	538
90% Point, °F	450	449	449	450	562	566
End Point, °F	489	521	521	522	606	612
% Recovery	98.0	99.0	99.5	99.5	98.5	98.1
% Residue	1.8	1.0	0.5	0.5	1.3	1.9
% Dist. Loss	0.2	0.0	0.0	0.0	0.2	0.0
Cetane Number	43.7	45.0	47.0	47	50	52
F.I.A. Analysis						
Aromatics, %	15.2	15.9	15.0	15.9	25.0	27.4
Olefins, %	2.5	0.0	0.0	1.5	0.0	0.0
Saturates, %	82.3	84.1	85.0	82.6	75.0	72.6
Total Sulfur	0.09	0.08	0.05	0.02	0.07	0.07
Gravity, °API at 60°F		44.8	44.6	44.8	36.9	37.6

---

(1) Initial 1000-Gal supply utilized until August 22, 1967, and used during original bus variability study.
(2) 1000-Gal supply utilized after August 22, 1967, until July 10, 1968.
(3) 1000-Gal supply utilized after July 10, 1968.
(4) Inspection of No. 1 diesel used by San Antonio Transit during fleet test of odor additive.
(5) 1000-Gal supply utilized until February 3, 1969.
(6) 1000-Gal supply utilized after February 3, 1969.

III. FLEET TEST OF A DIESEL FUEL ODOR ADDITIVE

The objective of this test was to illustrate the effectiveness of a commercially available diesel fuel additive for odor control during a prolonged period of field use. To this end, screening and selection of the additive material for use was made and a group of three similar city buses was selected from the San Antonio Transit fleet. The units were 45-passenger GM Truck and Coach Division Model TDH 4519 buses powered by Detroit Diesel 6V-71 six-cylinder, two-cycle, E type, two-valve engines. These engines were equipped with Type 60S injectors.

A. Initial Screening Tests

Four available candidate additives, all commercially or nearly commercially produced, were obtained and mixed in EM-3A-F, a number 1 kerosene type diesel fuel, according to the suppliers' recommendations. The candidate materials were coded "A," "B," "C," and "D," and blended with EM-3A-F to result in the following additive-treated fuels. Using procedures and evaluation conditions developed in Part I and utilized in Part II, each of the above additive-treated fuels were subjected to a routine odor evaluation using the SwRI odor panel.

Candidate Additive	Additive-Treated Fuel SwRI Code	Fuel Description
A	EM-64-F	25 gal EM-3A-F plus 11.2 ml Additive A
B	EM-65-F	25 gal EM-3A-F plus 500 ml Additive B
C	EM-68-F	20 gal EM-3A-F plus 80 ml Additive C
D	EM-69-F	20 gal EM-3A-F plus 150 ml Additive D

Shown on Table 3 is the overall summary of the odor evaluations for additive-treated fuel versus the untreated number 1 diesel fuel. Each item of data is the average panel response for that particular condition evaluated in quadruplicate on a random basis. This means that the five operating conditions were routinely evaluated in quadruplicate with four blank runs in which no exhaust samples were employed. The net changes shown on Table 3 reveal that, generally, none of the additives were highly successful in reducing the overall intensity ("D") or the most obvious of the qualities, the "B" rating. Only Additives A, B, and C seemed to have effect, and the magnitude of the change generally was less than one "D" intensity number, normally in the range of 0.3 to 0.7. Likewise, the change in "B" - burnt was also low, with the greatest net change appearing for the base fuel treated with Additive A.

To further investigate the differences indicated by the average panel responses and illustrated by the bar charts, a simple statistical test was applied to the odor data to determine if there was a statistical difference between the treated and untreated fuel. The statistical test, known as the "U" statistic, was widely used during the Part II evaluations of catalytic muffler devices. In effect, this nonparametric test is useful to screen the data identifying those instances in which a statistical difference occurred.

As shown in Table 3, only under a few conditions did there appear to be a statistically different odor rating given for the treated fuels. As established in the Part II program, statistical importance is given only when the U_s statistic is 2 or less for the case of identical sets of measurements with treated and untreated fuel. The "U" statistic only indicates whether or not a statistical difference is apparent and is unable by itself to establish the significance of the results. In the field of odor ratings by subjective, qualitative, quantitative means, experience would indicate that differences of 0.1 or 0.2 bottle numbers in intensity constitute no really significant difference, even though the statistical test may indicate otherwise. Using these guidelines, the statistically identified conditions of Table 3 may be reduced to only a few instances. The conclusion, as a result of this analysis, is that none of the treated fuels appeared to consistently and significantly alter the odor panel responses.

TABLE 3. OVERALL SUMMARY OF ODOR EVALUATIONS ADDITIVE-TREATED VS UNTREATED NO. 1 DIESEL FUEL

Vehicle: Bus 676

Engine: Detroit Diesel 6V-71 E

Operating Conditions	Test Date	Fuel Description	Average Odor Panel Responses "D" Composite	"B" Burnt-Smoky	"O" Oily	"A" Aromatic-Aldehydic	"P" Pungent
20 mph	5/17/68	EM-3A-F No. 1 Diesel	5.1	1.5	1.3	1.0	0.3
40 hp	5/10/68	EM-3A-F + Additive A	4.7	1.2	1.1	0.9	0.5
		Net Change	-0.4	-0.3	-0.2	-0.1	+0.2
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	5.1	1.5	1.3	1.0	0.3
	5/14/68	EM-3A-F + Additive B	4.4	1.1	1.0	0.8	0.4
		Net Change	-0.7	-0.4	-9.1	-0.2	+0.1
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	5.1	1.5	1.3	1.0	0.3
	5/15/68	EM-3A-F + Additive C	4.6	1.2	1.0	1.0	0.2
		Net Change	-0.5	-0.3	-0.3	0	-0.1
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	5.1	1.5	1.3	1.0	0.3
	5/16/68	EM-3A-F + Additive D	5.4	1.7	1.3	1.0	0.4
		Net Change	+0.3	+0.2	0	0	+0.1
		U_s Statistic	*	*	*	*	*
40 mph	5/17/68	EM-3A-F No. 1 Diesel	5.6	1.6	1.3	1.2	0.5
40 hp	5/10/68	EM-3A-F + Additive A	4.8	1.1	1.1	1.0	0.3
		Net Change	-0.8	-0.5	-0.2	-0.2	-0.2
		U_s Statistic	*	1	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	5.6	1.6	1.3	1.2	0.5
	5/14/68	EM-3A-F + Additive B	5.1	1.4	1.2	0.8	0.3
		Net Change	-0.5	-0.2	-0.1	-0.4	-0.2
		U_s Statistic	*	*	*	0.5	*
	5/17/68	EM-3A-F No. 1 Diesel	5.6	1.6	1.3	1.2	0.5
	5/15/68	EM-3A-F + Additive C	4.8	1.2	1.1	0.8	0.3
		Net Change	-0.8	-0.4	-0.2	-0.4	-0.2
		U_s Statistic	1	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	5.6	1.6	1.3	1.2	0.5
	5/16/68	EM-3A-F + Additive D	5.5	1.6	1.4	1.0	0.6
		Net Change	-0.1	0	+0.1	-0.2	+0.1
		U_s Statistic	*	*	*	*	*
Idle	5/17/68	EM-3A-F No. 1 Diesel	6.5	2.1	1.8	1.3	1.1
	5/10/68	EM-3A-F + Additive A	6.4	1.9	1.5	1.3	1.0
		Net Change	-0.1	-0.2	-0.3	0	-0.1
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	6.5	2.1	1.8	1.3	1.1
	5/14/68	EM-3A-F + Additive B	7.0	2.1	1.7	1.4	1.3
		Net Change	+0.5	0	-0.1	+0.1	+0.2
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	6.5	2.1	1.8	1.3	1.1
	5/15/68	EM-3A-F + Additive C	6.7	2.0	1.6	1.4	1.1
		Net Change	+0.2	-0.1	-0.2	+0.1	0
		U_s Statistic	*	1	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	6.5	2.1	1.8	1.3	1.1
	5/15/68	EM-3A-F + Additive D	6.5	2.0	1.9	1.3	1.1
		Net Change	0	-0.1	+0.1	0	0
		U_s Statistic	*	*	*	*	*
Idle-Acceleration	5/17/68	EM-3A-F No. 1 Diesel	7.7	2.5	2.1	1.5	1.7
	5/10/68	EM-3A-F + Additive A	7.3	2.2	1.9	1.4	1.4
		Net Change	-0.4	-0.3	-0.2	-0.1	-0.3
		U_s Statistic	*	0	1.5	*	*
	5/17/68	EM-3A-F No. 1 Diesel	7.7	2.5	2.1	1.5	1.7
	5/14/68	EM-3A-F + Additive B	7.7	2.5	2.0	1.4	1.5
		Net Change	0	0	-0.1	-0.1	-0.2
		U_s Statistic	*	*	1.5	*	*
	5/17/68	EM-3A-F No. 1 Diesel	7.7	2.5	2.1	1.5	1.7
	5/15/68	EM-3A-F + Additive C	7.2	2.4	1.9	1.3	1.3
		Net Change	-0.5	-0.1	-0.2	-0.2	-0.4
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	7.7	2.5	2.1	1.5	1.7
	5/16/68	EM-3A-F + Additive D	7.6	2.5	2.0	1.3	1.5
		Net Change	-0.1	0	-0.1	-0.2	-0.2
		U_s Statistic	*	*	1.5	*	*
Deceleration	5/17/68	EM-3A-F No. 1 Diesel	6.7	2.1	1.9	1.3	1.1
	5/10/68	EM-3A-F + Additive A	6.9	2.0	1.8	1.4	1.2
		Net Change	+0.2	-0.1	-0.1	+0.1	+0.1
		U_s Statistic	*	1	*	2	*
	5/17/68	EM-3A-F No. 1 Diesel	6.7	2.1	1.9	1.3	1.1
	5/14/68	EM-3A-F + Additive B	6.9	2.0	1.8	1.4	1.2
		Net Change	+0.2	-0.1	-0.1	+0.1	+0.1
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	6.7	2.1	1.9	1.3	1.1
	5/15/68	EM-3A-F + Additive C	6.4	2.1	1.7	1.3	1.0
		Net Change	-0.3	0	-0.2	0	-0.1
		U_s Statistic	*	*	*	*	*
	5/17/68	EM-3A-F No. 1 Diesel	6.7	2.1	1.9	1.3	1.1
	5/16/68	EM-3A-F + Additive D	7.0	2.2	1.9	1.3	1.4
		Net Change	+0.3	-0.1	0	0	+0.3
		U_s Statistic	*	*	*	*	*

---

*U_s greater than 2, no statistical difference apparent.

The bar graphs shown in Figures 17 through 20 compare odor ratings for the four additive treated fuels with the untreated fuel. For purposes of these charts, an arbitrary scale equal to the simple addition of the average "D" + "B" + "O" + "A" + "P" ratings is used. This arbitrarily weights the "D" response, the most important indicator of diesel exhaust odor, relative to the four qualities. To permit direct comparison, the overall average four-run panel responses are listed within each bar. Using these four charts, it is readily apparent that none of the four additives investigated substantially and consistently reduced the overall diesel odor. Under four of the five operating conditions, Additives A and C, Figures 17 and 19 seemed to have a slight effect. In the case of Additive B, Figure 18, it appeared that changes were evident under only three of the five conditions. Of the four, Additive D was the least effective as shown in Figure 20.

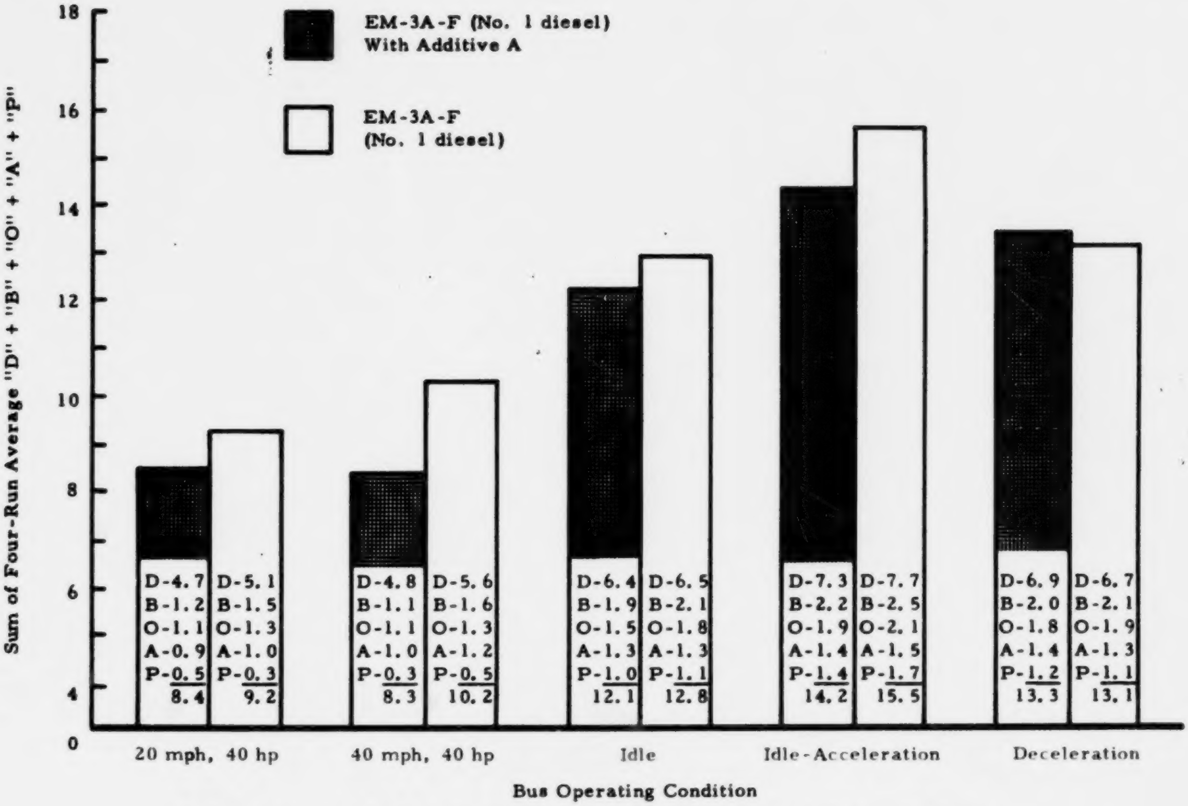


FIGURE 17. OVERALL COMPARISON OF DIESEL ODOR EVALUATION OF A NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE A

The odor data were then reviewed from two other approaches. The first was to consider the order of obviousness by which the odor panel recorded their responses. The panel rates the four qualities on the basis of obviousness or what comes through to them first, and this method has been very useful in pinpointing a change in odor character even though not indicated by the overall "D" response. Throughout this experimental series, however, no indication of a shift or reversal in the order of obviousness was recorded. The usual "B" - burnt-smoky continued to be most obvious and of most importance next to the "D" rating. As in previous two-cycle experiments, the "P" - pungent rating was usually least obvious. The "O" and "A" ratings generally comprised the second and third most obvious. The other method used was to request at the end of each day's operation a paragraph written by each panelist describing overall differences, if any, between that particular day's operation and a

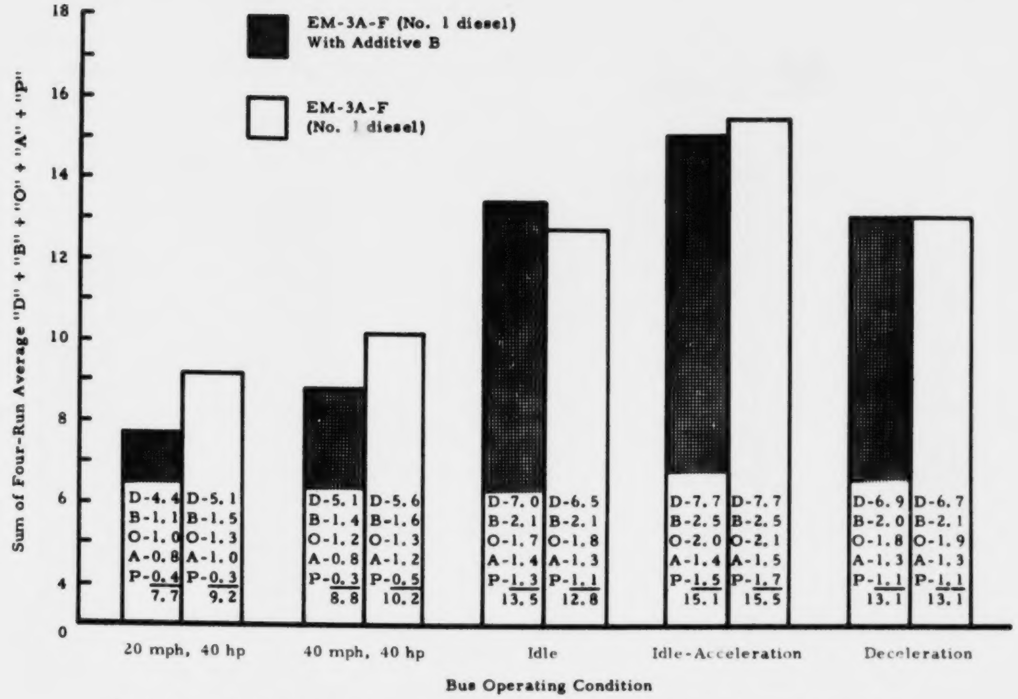


FIGURE 18. OVERALL COMPARISON OF DIESEL ODOR EVALUATION OF A NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE B

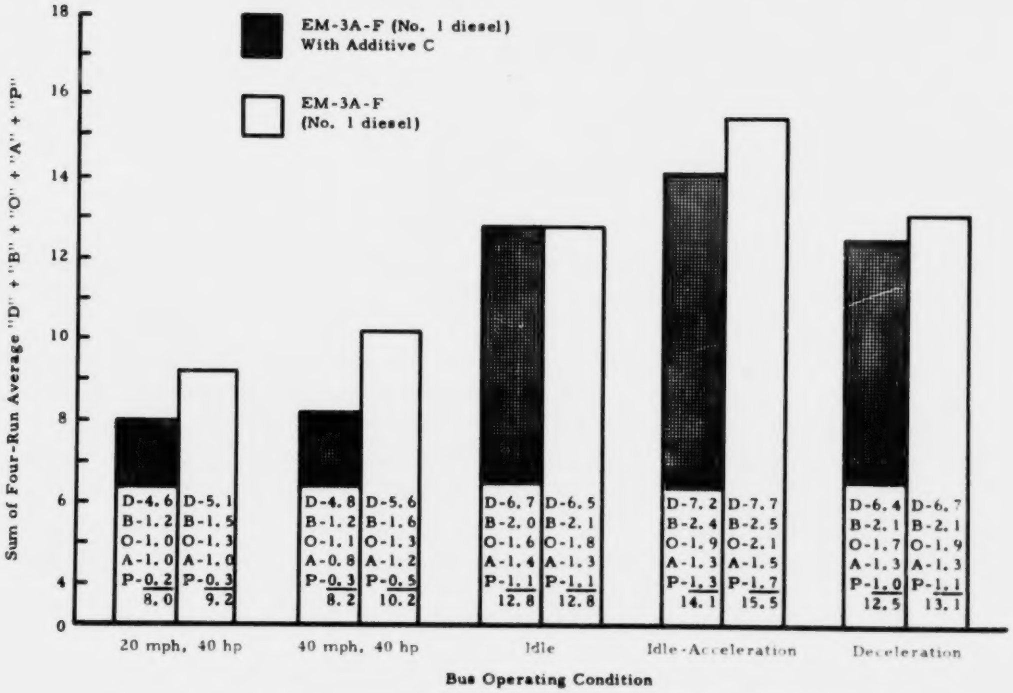


FIGURE 19. OVERALL COMPARISON OF DIESEL ODOR EVALUATION OF A NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE C

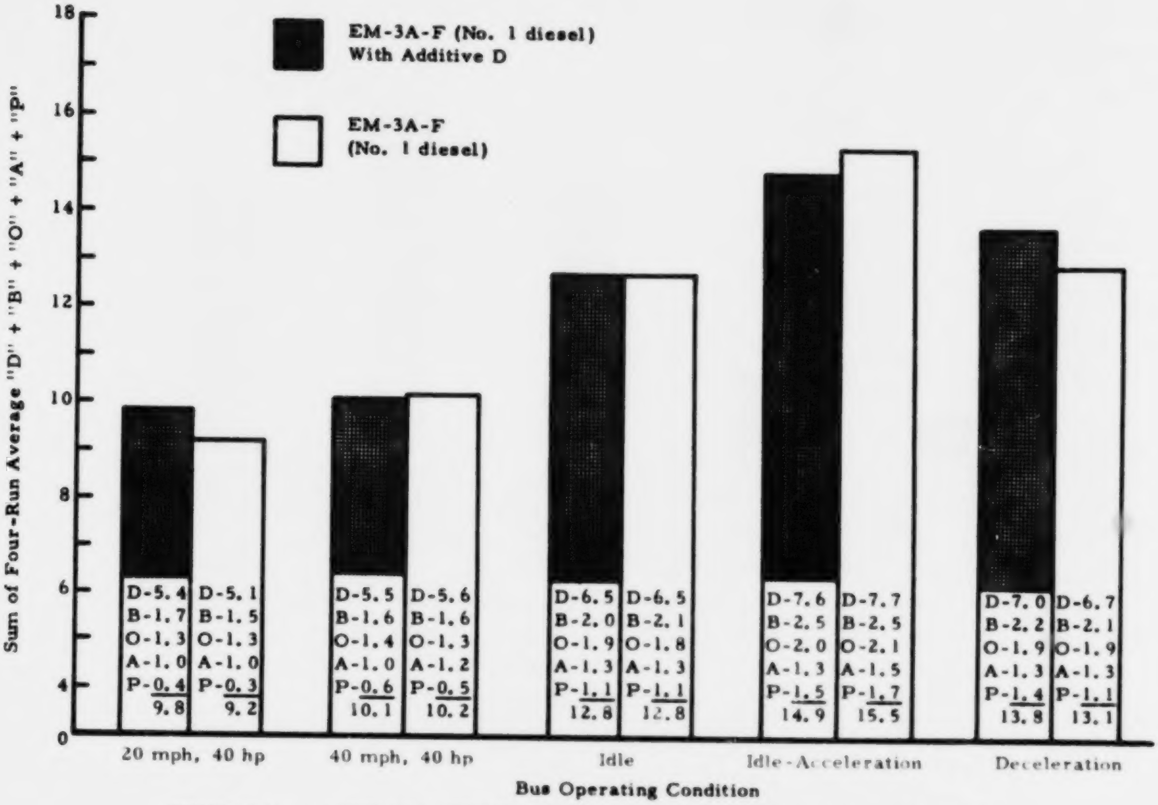


FIGURE 20. OVERALL COMPARISON OF DIESEL ODOR EVALUATIONS OF A NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE D

previous day which was conducted with untreated fuel. These paragraphs were summarized, and their results are listed briefly as follows:

Additive	Summary of Panel Comments
A	Same (or slightly lower) intensity as untreated fuel but not the same kerosene type smell or strong diesel odor. Not as penetrating, milder, more aromatic.
B	These odors were less penetrating than No. 1 fuel, although the transient runs were very strong. Not as much burnt quality present overall.
C	These runs were sweet, sour, and not as penetrating as No. 1 fuel. Not strong in kerosene smell. Slightly milder.
D	Same intensities as No. 1 fuel, but different qualities. No kerosene odor. Sweeter, but not as sour as Additives B and C.

After the test series was completely over, the panel was asked to rank the four additive fuels, identified as particular days of operation, in the order in which the greatest change had been noticed in the overall exhaust odor. This survey resulted in Additive A being voted as effecting the greatest overall change and Additive D having the least effect. Although the panel was unanimous in the selection of the most effective and least effective, there was a slight divergence of opinion of Additives B and C with Additive C being slightly more effective than B. The ranking of these four additive treated fuels in the order of perceived effectiveness by the human odor panel does not constitute an opinion survey as to the order of preference, objectionability, or acceptability of the resulting diesel exhaust odor, but is merely intended to assist in the overall selection of a suitable odor additive for fleet test.

During the additive screening tests, 3 days were devoted to the operation with untreated base No. 1 diesel fuel (EM-3A-F), to obtain baseline data at desired intervals for comparison purposes. The baseline data were obtained on May 9, 13, and 17, at the beginning, midway, and the end of the test series. For comparison purposes, it was desired to select 1 of the 3 days as "most representative." To establish the most representative day, comparisons were made between each of the three baseline days. The May 17, 1968, results consistently were about midway between the May 9 and 13 data, and were adjudged to represent an approximate mean. Shown on Table 4 is an overall summary of the three baseline odor evaluations. There was essentially no difference between the 3 days of baseline results shown by the net change and U_s statistic results.

A description of procedures, conditions, and complete odor evaluation data for each of the screening tests are included in Appendix A. Tables 1 through 5 of Appendix A describe the procedures used to evaluate the odor during five conditions of 20- and 40-mph cruise, idle after 30-mph cruise, acceleration after prolonged idle, and deceleration from 40-mph cruise, all at 100:1 dilution level.

These conditions were selected as representative of typical urban driving and as modes in which maximum odor is produced. The first three operating conditions represent steady-state conditions, and the odor panel rates the exhaust over a period of 50 to 70 sec, usually with three or four sniffs at will. The last two conditions represent transient operation in which full vehicle inertia (25,000-lb vehicle weight) is simulated by means of the SwRI road simulation system. As point exposure of the panel to the diesel exhaust odor was found to be the optimum procedure for evaluation, the transients are repeated to permit the panel to evaluate the "D" and four qualities.

Each day's operation was summarized by run condition, and an overall four-run average is shown for the "D," "B," "O," "A," and "P" ratings (shown in Table 6, Appendix A). An additional five tables contain the individual response distribution for each of the ratings and show at a glance the distribution of the individual panel responses for each of the twenty-four runs which comprise the routine evaluation. As an example of these supporting tables, refer to Tables 6A-E of Appendix A for the "D," "B," "O," "A," and "P" supporting information, respectively. Similarly, the other evaluations under this test series are contained on Tables 7 through 12 of Appendix A.

B. Fleet Test

Using the ten-bus variability results of Part I (Ref 1), three city buses powered by the Detroit Diesel 6V-71-E type engine with 60S injectors were selected for a 6-month fleet test of additive A, found best of those available during the screening tests.

1. Approach

The approach was to conduct back-to-back emissions tests at the beginning, after 3 months, and at the end of 6 months of operation. The San Antonio Transit System officials cooperated by operating the three buses on a fairly rigorous schedule so that as much mileage as possible could be accumulated during the 6 months. Smoke, odor, and exhaust emissions including acrolein, aldehydes, formaldehyde, carbon monoxide (CO), carbon dioxide (CO_2), total unburned hydrocarbons (HC), nitrogen oxides (NO_x), nitric oxide (NO), and, where possible, nitrogen dioxide (NO_2) were measured at the beginning and end of the test. Since it was doubtful that the additive would noticeably affect these exhaust constituents, only odor and smoke were measured at the interim inspection. In addition to emissions performance, records were maintained of fuel and oil consumption, engine maintenance, and additive usage.

2. Test Preparations

No maintenance or preparations to the engine or vehicle were made as part of starting this 6-month duration test. The usual No. 1 kerosene type diesel fuel was treated with the manufacturer's recommended amount of additive (1 lb or pt per 1000 gal). This additive-treated fuel was known as EM-72-F and consisted of the usual Transit fuel, EM-73-F, plus the additive.

TABLE 4. OVERALL SUMMARY OF ODOR EVALUATIONS SELECTION OF MOST REPRESENTATIVE BASELINE OPERATION FOR COMPARISON OF ADDITIVE-TREATED FUELS

Vehicle: Bus 676
Fuel: EM-3A-F (No. 1 Diesel)

Engine: Detroit Diesel 6V-71E

Operating Conditions	Test Date	"D" Composite	"B" Burnt-Smoky	"O" Oily	"A" Aromatic-Aldehydic	"P" Pungent
20 mph	5/17/68	5.1	1.5	1.3	1.0	0.3
40 mph	5/9/68	5.4	1.5	1.2	1.3	0.3
	Net Change	+0.3	0	-0.1	+0.3	0
	U_s Statistic	*	*	*	0	*
	5/17/68	5.1	1.5	1.3	1.0	0.3
	5/13/68	4.9	1.4	1.2	1.0	0.4
	Net Change	-0.2	-0.1	-0.1	0	+0.1
	U_s Statistic	*	*	*	*	*
40 mph	5/17/68	5.6	1.6	1.3	1.2	0.5
40 hp	5/9/68	5.6	1.5	1.3	1.2	0.6
	Net Change	0	-0.1	0	0	+0.1
	U_s Statistic	*	*	*	*	*
	5/17/68	5.6	1.6	1.3	1.2	0.5
	5/13/68	5.6	1.7	1.5	1.1	0.6
	Net Change	0	+0.1	+0.2	-0.1	+0.1
	U_s Statistic	*	*	*	*	*
Idle	5/17/68	6.5	2.1	1.8	1.3	1.1
	5/9/68	6.8	2.0	1.7	1.6	1.0
	Net Change	+0.3	-0.1	-0.1	+0.3	-0.1
	U_s Statistic	*	*	*	*	*
	5/17/68	6.5	2.1	1.8	1.3	1.1
	5/13/68	6.7	2.1	1.9	1.2	1.1
	Net Change	+0.2	0	+0.1	-0.1	0
	U_s Statistic	*	*	*	*	*
Idle-Acceleration	5/17/68	7.7	2.5	2.1	1.5	1.7
	5/9/68	7.8	2.3	2.0	1.3	1.2
	Net Change	+0.1	-0.2	-0.1	-0.2	-0.5
	U_s Statistic	*	*	*	*	1
	5/17/68	7.7	2.5	2.1	1.5	1.7
	5/13/68	7.1	2.2	2.0	1.4	1.3
	Net Change	-0.6	-0.3	-0.1	-0.1	-0.4
	U_s Statistic	*	0	*	*	2
Deceleration	5/17/68	6.7	2.1	1.9	1.3	1.1
	5/9/68	7.3	2.2	1.5	1.5	1.1
	Net Change	+0.6	+0.1	-0.4	+0.2	0
	U_s Statistic	*	*	*	1	*
	5/17/68	6.7	2.1	1.9	1.3	1.1
	5/13/68	7.1	2.2	1.3	1.3	1.1
	Net Change	+0.4	+0.1	-0.6	0	0
	U_s Statistic	*	*	0.5	*	*

---

*U_s greater than 2, no statistical difference apparent.

Since only three vehicles from the large fleet of San Antonio Transit buses were involved, addition of additive was in premeasured can quantities direct to the vehicle fuel tank. The procedure was to fill the vehicle tank as usual and then add the correct premeasured can of additive needed for the amount of fuel. Because of the highly concentrated form of the additive, predilution in No. 1 fuel was necessary. One-pound quantities were blended into 3-gal quantities of No. 1 fuel and the resulting diluted mixture was measured and poured into pint and quart containers in quantities sufficient for fuel treatment.

The premeasured pint and quart cans were labeled for 10, 20, 30, 40, 50, 60, 70, and 80 gal of fuel. Predilution in No. 1 fuel was expected to promote mixing. A typical inspection of the fuel used by the San Antonio Transit System, coded EM-73-F, is shown in Table 5. This material was used during the interim and final laboratory test and performance evaluations and is very similar in all respects to the laboratory supply of No. 1 diesel.

TABLE 5. INSPECTION DATA FOR NO. 1 KEROSENE TYPE COMMERCIAL DIESEL FUEL USED DURING FLEET TEST OF ODOR ADDITIVE
(Typical Sample)

Commercial Fuel Type	1
Sample Information Code	EM-73-F
Property	
Distillation Range	
Initial Boiling Point, °F	336
10% Point, °F	364
20% Point, °F	371
30% Point, °F	384
40% Point, °F	394
50% Point, °F	402
60% Point, °F	410
70% Point, °F	418
80% Point, °F	430
90% Point, °F	450
End Point, °F	522
% Recovery	99.5
% Residue	0.5
% Dist. Loss	0.0
Cetane Number	47
F.I.A. Analysis	
Aromatics, %	15.87
Olefins, %	1.47
Saturates, %	82.66
Total Sulfur	0.02
Gravity, °API at 60°F	44.8

3. Results

To summarize the extensive data obtained during this test, overall summaries are presented for each bus covering the three inspection periods with and without additive-treated fuel. First, the overall odor summary, next, the smoke results, and last, the exhaust chemistry summary is presented for Buses 676, 678, and 680.

The odor data, Tables 6, 9, and 12 for Buses 676, 678, and 680, show that, most of the time, the odor additive was effective in reducing the odor ratings slightly. The magnitude of the changes, however, are slight such that, when subjected to the nonparametric U_s test for statistical difference only a few instances may be considered a real change (i.e., not within the variability of the experimental data). This is indicated by the U_s statistic for each comparison which list those instances in which the U test was significant (U_s = 0 to 2). All other instances are marked with an asterisk. The reader must note, however, that all changes were not reductions by the untreated versus the treated ratings. In summary of the odor performance ratings, it is evident that the odor additive did not demonstrate consistent or widespread effectiveness and that its technical effect on perceived odor via the human panel PHS Q/I method was minimal.

Although no particular smoke reduction was expected by using this odor additive, periodic smoke tests were made using the PHS full-flow, light-extinction meter. The results of these tests are summarized in Tables 7, 10, and 13 for Buses 676, 678, and 680, and confirm the additive to have little or no beneficial effect on visible smoke. In many instances, and especially with Bus 676, the smoke was slightly higher with the additive-treated fuel than with the untreated fuel. No effect on observed vehicle power output or engine performance was noted.

A similar lack of gross effect on the other exhaust emissions was found for all vehicles both at the beginning and end of test. Tables 8, 11, and 14 list only a few emissions under a few conditions to have a statistical difference. Some of those show an increase or decrease in emissions which, when viewed with regard to the accuracy and repeatability-reproducibility of the instrumental-chemical procedures, do not really represent an engineering difference.

In a final attempt to demonstrate effective technical odor improvement, Bus 676 was operated at the recommended, and two and three times the recommended treatment level. The odor panel results and smoke measurements are summarized in Tables 15 and 16. The odor ratings, both individually and cumulatively, per Table 11 seemed to decrease as the dose level was increased except for the idle-acceleration condition. Odor changes were judged "slight," particularly in view of the additive treatment levels required. Smoke data, Table 16, indicated mostly that the effect of increasing additive dose was to increase the smoke under both steady state and transient conditions.

The fleet test resulted in the generation of a large amount of data, most of which is summarized and included in Appendix A starting with Table 20. The first few tables, Tables 20 through 23, cover the smoke and chemistry measurement procedures. Tables 25 through 86 contain the odor summaries and supporting odor data for the three evaluations of each of the three vehicles. A smoke data sheet and chemistry emissions summary are also included as are the results of statistical tests (U test) to determine statistical difference in each back-to-back test. By back-to-back is meant each bus inspection consisted of 2 days of operation, the first day with the bus as-received with additive-treated fuel and the second day with the same fuel less additive. The constant speed (four conditions in quadruplicate, 20-, 30-, and 40-mph, 40-hp cruises and an idle) odor and chemistry results are obtained simultaneously in the morning and the transient odor runs (two conditions of idle-accel and decel from cruise, also in quadruplicate) and the smoke inspection were performed in the afternoon. Flysheets are included in the appendix to separate the initial inspection data (Tables 24 through 50), interim inspection (Tables 51 through 65), and the final evaluation (Tables 66 through 86).

4. Cost Effectiveness

A number of means are usually employed to express cost effectiveness of a control method. They all relate to how much operating and investment cost is required per unit of control on a time or mileage or fuel consumption basis. High cost-effectiveness ratios mean that the cost is high for the amount of improvement possible. In the case of the diesel fuel odor additive, investment costs to the user would be nil or essentially nil because the usual practice is to have the fuel supplier blend the additive and pass the cost of blending and handling as well as the additive cost on to the user.

Correspondence with the manufacturer indicates that the price per pound could range from \$1.25/lb in carload quantities to \$2.00/lb in 55-gal drum quantities. It was reported that a rate of \$1.68/lb, on the basis of 20,000 lb/yr in 55-gal drums was a realistic cost of the additive to a large user. The \$1.68/lb equates to \$1.68/1000 gal which, at an average fuel consumption of 3.94 miles/gal for the three test vehicles (see Appendix A for complete data) works out to be \$0.000426 per mile. This does not include shipping, handling, and blending costs which would be variable and depend on location, etc. No other costs such as engine maintenance or early overhaul would be expected. No preparation cost to the engine or vehicle tankage and fuel supply system is involved. About the only cost foreseen is the cost of procurement, assuming all bus fuel would be procured with the additive or all fuel would be treated and no special storage tanks or transfer or dispersing pumps would be necessary. No special training of personnel or additional safeguards appear necessary. As a result, the cost of the additive may be considered as strictly an operating cost. For details of the mileage accumulation and fuel, oil, and additive consumption, please refer to Appendix A, Tables 90 to 92. A

TABLE 6. OVERALL SUMMARY OF ODOR EVALUATIONS, ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL
(Bus 676)

Operating Conditions	Inspection Period	Test Months	Test Miles	Test Date	Test Fuel	Average Odor Panel Responses				
						"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph 40 hp	Initial	0	0	8/15/68	Untreated	6.3	1.9	1.8	1.0	1.1
				8/14/68	Treated	6.1	1.8	1.9	1.0	0.9
					Net Change	-0.2	-0.1	+0.1	0	-0.2
					U_s Statistic	*	*	*	*	*
	Interim	3	10,610	11/15/68	Untreated	6.0	1.8	1.5	1.2	1.1
				11/14/68	Treated	5.3	1.5	1.4	1.1	1.0
					Net Change	-0.7	-0.3	-0.1	-0.1	-0.1
					U_s Statistic	0	*	*	*	2
	Final	6	19,220	2/21/69	Untreated	5.6	1.4	1.3	1.1	1.0
				2/20/69	Treated	5.4	1.6	1.3	0.9	1.3
					Net Change	-0.2	+0.2	0	-0.2	+0.3
					U_s Statistic	*	*	*	0	0
30 mph 40 hp	Initial	0	0	8/15/66	Untreated	This condition not run during initial tests				
				8/14/68	Treated					
					Net Change					
					U_s Statistic					
	Interim	3	10,610	11/15/68	Untreated	5.5	1.7	1.4	1.1	1.0
				11/14/68	Treated	5.5	1.7	1.5	1.0	0.9
					Net Change	0	0	+0.1	-0.1	-0.1
					U_s Statistic	*	*	*	*	*
	Final	6	19,220	2/21/69	Untreated	5.6	1.5	1.4	1.1	1.0
				2/20/69	Treated	5.5	1.6	1.4	1.0	1.4
					Net Change	-0.1	+0.1	0	-0.1	+0.4
					U_s Statistic	*	*	*	2	0
40 mph 40 hp	Initial	0	0	8/15/68	Untreated	6.3	1.9	1.8	1.0	1.1
				8/14/68	Treated	6.2	1.8	1.8	1.1	1.0
					Net Change	-0.1	-0.1	0	+0.1	-0.1
					U_s Statistic	*	*	*	*	*
	Interim	3	10,610	11/15/68	Untreated	5.8	1.7	1.4	1.2	1.0
				11/14/68	Treated	6.1	1.9	1.7	1.0	1.0
					Net Change	+0.3	+0.2	+0.3	-0.2	0
					U_s Statistic	*	0.5	0.5	*	*
	Final	6	19,220	2/21/69	Untreated	6.0	1.9	1.5	1.2	1.0
				2/20/69	Treated	5.7	1.8	1.5	1.1	1.5
					Net Change	-0.3	-0.1	0	-0.1	+0.5
					U_s Statistic	2	*	*	*	0
Idle	Initial	0	0	8/15/68	Untreated	5.8	1.8	1.6	0.9	1.0
				8/14/68	Treated	4.7	1.5	1.2	1.0	0.6
					Net Change	-1.1	-0.3	-0.4	+0.1	-0.4
					U_s Statistic	0	0	0	*	0
	Interim	3	10,610	11/15/68	Untreated	5.2	1.5	1.1	1.3	1.0
				11/14/68	Treated	5.7	1.8	1.3	1.4	0.9
					Net Change	+0.5	+0.3	+0.2	+0.1	-0.1
					U_s Statistic	*	1.5	0	*	*
	Final	6	19,220	2/21/69	Untreated	6.0	1.8	1.6	1.2	1.0
				2/20/69	Treated	5.7	1.8	1.5	1.1	1.5
					Net Change	-0.3	0	-0.1	-0.1	+0.5
					U_s Statistic	2	*	*	*	0
Idle-Acceleration	Initial	0	0	8/15/68	Untreated	6.8	2.0	1.9	1.0	1.3
				8/14/68	Treated	6.2	1.9	1.8	1.1	1.1
					Net Change	-0.6	-0.1	-0.1	+0.1	-0.2
					U_s Statistic	1.5	*	*	*	1
	Interim	3	10,610	11/15/68	Untreated	6.5	2.2	1.8	1.3	1.3
				11/14/68	Treated	6.1	2.0	1.6	1.1	1.1
					Net Change	-0.4	-0.2	-0.2	-0.2	-0.2
					U_s Statistic	*	*	2	*	*
	Final	6	19,220	2/21/69	Untreated	6.1	1.9	1.8	1.1	1.1
				2/20/69	Treated	6.8	2.1	1.7	1.2	1.7
					Net Change	+0.7	+0.2	-0.1	+0.1	+0.6
					U_s Statistic	0	0.5	*	*	0
Deceleration	Initial	0	0	8/15/68	Untreated	5.1	1.6	1.3	0.9	0.8
				8/14/68	Treated	4.6	1.3	1.2	0.9	0.7
					Net Change	-0.5	-0.3	-0.1	0	-0.1
					U_s Statistic	1.5	*	*	*	*
	Interim	3	10,610	11/15/68	Untreated	4.9	1.4	1.1	1.2	0.8
				11/14/68	Treated	4.8	1.3	1.1	1.1	0.5
					Net Change	-0.1	-0.1	0	-0.1	-0.3
					U_s Statistic	*	*	*	*	*
	Final	6	19,220	2/21/69	Untreated	5.0	1.4	1.2	1.1	0.9
				2/20/69	Treated	5.1	1.5	1.1	1.1	1.1
					Net Change	+0.1	+0.1	-0.1	0	+0.2
					U_s Statistic	*	*	*	*	*

---

*U_s greater than 2, no statistical difference apparent.

TABLE 7. OVERALL SUMMARY OF SMOKE EVALUATIONS, ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL

(Bus 676)

Constant Speed (All open rack--maximum power output)

Vehicle Speed, mph	Test Date	Test Months	Test Miles	Average PHS Smoke Reading, Percent Opacity: Untreated	Average PHS Smoke Reading, Percent Opacity: Treated	Smoke Reduction, Percent Opacity
20	8/14, 15/68	0	0	13.3	12.3	1.0
	11/14, 15/68	3	10,610	12.0	13.3	(1.3)[a]
	2/20, 21/69	6	19,220	8.0	10.0	(2.0)
25	8/14, 15/68	0	0	9.7	9.3	0.4
	11/14, 15/68	3	10,610	9.7	11.0	(1.3)
	2/20, 21/69	6	19,220	6.0	9.0	(3.0)
30	8/14, 15/68	0	0	9.0	9.0	0
	11/14, 15/68	3	10,610	9.0	10.3	(1.3)
	2/20, 21/69	6	19,220	6.0	8.0	(2.0)
35	8/14, 15/68	0	0	7.7	7.7	0
	11/14, 15/68	3	10,610	8.3	10.0	(1.7)
	2/20, 21/69	6	19,220	5.3	7.3	(2.0)

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Test Date	Test Months	Test Miles	Average PHS Smoke Readings, Percent Opacity: Untreated	Average PHS Smoke Readings, Percent Opacity: Treated	Smoke Reduction, Percent Opacity
Engine Start	8/14, 15/68	0	0	13.7	14.7	(1.0)
	11/14, 15/68	3	10,610	14.3	15.0	(0.7)
	2/20, 21/69	6	19,220	14.3	13.3	(1.0)
During Acceleration	8/14, 15/68	0	0	8.7	7.3	1.4
	11/14, 15/68	3	10,610	7.7	8.0	(0.3)
	2/20, 21/69	6	19,220	6.0	7.0	(1.0)
After Upshift	8/14, 15/68	0	0	8.0	8.7	(0.7)
	11/14, 15/68	3	10,610	7.7	8.7	(1.0)
	2/20, 21/69	6	19,220	5.3	5.7	(0.4)

---

[a] ( ) indicates increase in smoke with additive-treated fuel.

TABLE 8. SUMMARY OF AVERAGE "AS-MEASURED" EXHAUST EMISSIONS MEASUREMENTS ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL

(Bus 678)

Operating Conditions	Test Date	Test Months	Test Miles	Test Fuel	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm NO_2	NO, ppm
20 mph 40 hp	8/16/68	0	0	Untreated	765	4.88	1751	2	31	18	955	
	8/13/68			Treated	775	4.20	2125	3	32	19	915	
				U_s Statistic	•	0		•	•	•	0	
	2/21/69	6	19,220	Untreated	480	4.40	1949	3	20	9	899	1040
	2/20/69			Treated	408	4.40	2187	2	23	9	900	1030
				U_s Statistic	0	•	0	2	•	•	•	•
30 mph 40 hp	8/16/68	0	0	Untreated	225	4.25	1699	2	28	13	684	
	8/3/68			Treated	185	3.59	1915	2	25	13	727	
				U_s Statistic	0	0		•		•	2	
	2/21/69	6	19,220	Untreated	208	3.40	1914	2	16	6	724	848
	2/20/69			Treated	199	3.40	2030	1	19	7	782	828
				U_s Statistic	•	•	0	•	•	•	•	•
40 mph 40 hp	8/16/68	0	0	Untreated	209	3.85	1716	1	22	11	655	
	8/13/68			Treated	155	3.68	1813	1	23	11	658	
				U_s Statistic	0	•		•	•	•	•	
	2/21/69	6	19,220	Untreated	180	3.30	1868	1	18	6	690	754
	2/20/69			Treated	176	3.20	1978	2	20	7	678	735
				U_s Statistic	•	•	0	•	•	•	•	•
Idle	8/16/68	0	0	Untreated	225	1.29	659	2	22	14	294	
	8/13/68			Treated	165	1.08	625	1	24	13	262	
				U_s Statistic	0	1.5		•	•	•	0.5	
	2/21/69	6	19,220	Untreated	256	0.90	546	3	23	9	228	265
	2/20/69			Treated	215	0.80	563	3	20	10	213	220
				U_s Statistic	0	•	•	•	•	•	•	0

•U_s statistic greater than 2, no statistical difference apparent.

TABLE 9. OVERALL SUMMARY OF ODOR EVALUATIONS, ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL
(Bus 678)

Operating Conditions	Inspection Period	Test Months	Test Miles	Test Date	Test Fuel	Average Odor Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph 40 hp	Initial	0	0	8/21/68	Untreated	6.6	2.0	1.9	1.1	1.5
				8/20/68	Treated	6.3	2.0	1.8	1.2	1.2
					Net Change	-0.3	0	-0.1	+0.1	-0.3
					U_s Statistic	*	*	*	*	*
	Interim	3	7,531	11/19/68	Untreated	5.8	1.8	1.5	1.2	1.0
				11/18/68	Treated	5.7	1.8	1.5	1.2	1.0
					Net Change	-0.1	0	0	0	0
					U_s Statistic	*	*	*	*	*
	Final	6	20,685	3/3/69	Untreated	4.9	1.3	1.1	1.0	0.7
				2/27/69	Treated	5.5	1.7	1.5	1.0	1.1
					Net Change	+0.6	+0.4	+0.4	0	+0.4
					U_s Statistic	0	0.5	0	*	1
30 mph 40 hp	Initial	0	0	8/21/68	Untreated	This condition not run during initial tests				
				8/20/68	Treated					
					Net Change					
					U_s Statistic					
	Interim	3	7,531	11/19/68	Untreated	5.2	1.6	1.4	1.1	0.8
				11/18/68	Treated	5.5	1.7	1.3	1.1	1.0
					Net Change	+0.3	+0.1	-0.1	0	+0.2
					U_s Statistic	*	*	*	*	1
	Final	6	20,685	3/3/69	Untreated	4.9	1.4	1.3	1.1	0.8
				2/27/69	Treated	5.4	1.8	1.4	1.0	0.9
					Net Change	+0.5	+0.4	+0.1	-0.1	+0.1
					U_s Statistic	*	2	*	*	*
40 mph 40 hp	Initial	0	0	8/21/68	Untreated	5.8	1.9	1.8	1.0	1.2
				8/20/68	Treated	6.4	2.0	1.9	1.4	1.2
					Net Change	+0.6	+0.1	+0.1	+0.4	0
					U_s Statistic	*	*	*	*	*
	Interim	3	7,531	11/19/68	Untreated	5.8	2.0	1.5	1.2	1.2
				11/18/68	Treated	5.6	1.7	1.5	1.1	0.9
					Net Change	-0.2	-0.3	0	-0.1	-0.3
					U_s Statistic	*	*	*	*	*
	Final	6	20,685	3/1/69	Untreated	5.3	1.4	1.3	1.1	0.7
				2/27/69	Treated	5.4	1.7	1.4	1.0	0.9
					Net Change	+0.1	+0.3	+0.1	-0.1	+0.2
					U_s Statistic	*	*	*	2	0
Idle	Initial	0	0	8/21/68	Untreated	5.8	1.8	1.7	1.0	1.0
				8/20/68	Treated	5.6	2.0	1.6	1.2	1.0
					Net Change	-0.2	+0.2	-0.1	+0.2	0
					U_s Statistic	*	*	*	*	*
	Interim	3	7,531	11/19/68	Untreated	5.8	1.9	1.6	1.2	1.0
				11/18/68	Treated	6.2	2.0	1.5	1.3	1.1
					Net Change	+0.4	+0.1	-0.1	+0.1	+0.1
					U_s Statistic	*	*	*	*	*
	Final	6	20,685	3/1/69	Untreated	5.3	1.5	1.4	1.1	0.8
				2/27/69	Treated	5.7	1.8	1.5	1.2	0.9
					Net Change	+0.4	+0.3	+0.1	+0.1	+0.1
					U_s Statistic	*	1.5	*	1.5	*
Idle-Acceleration	Initial	0	0	8/21/68	Untreated	6.2	1.9	1.9	1.1	1.3
				8/20/68	Treated	6.4	2.0	1.9	1.1	1.2
					Net Change	+0.2	+0.1	0	0	-0.1
					U_s Statistic	*	*	*	*	*
	Interim	3	7,531	11/19/68	Untreated	6.3	1.9	1.6	1.3	1.2
				11/18/68	Treated	6.0	1.9	1.6	1.2	1.2
					Net Change	-0.3	0	0	-0.1	0
					U_s Statistic	*	*	*	*	*
	Final	6	20,685	3/1/69	Untreated	6.3	2.1	1.6	1.0	1.1
				2/27/69	Treated	6.1	2.0	1.9	1.2	1.1
					Net Change	-0.2	-0.1	+0.3	+0.2	0
					U_s Statistic	*	*	*	0.5	*
Deceleration	Initial	0	0	8/21/68	Untreated	5.4	1.8	1.8	1.0	0.9
				8/20/68	Treated	5.1	1.8	1.4	1.0	0.9
					Net Change	-0.3	0	-0.4	0	0
					U_s Statistic	*	*	0.5	*	*
	Interim	3	7,531	11/19/68	Untreated	5.0	1.5	1.3	1.0	0.7
				11/18/68	Treated	5.4	1.7	1.4	1.2	0.9
					Net Change	+0.4	+0.2	+0.1	+0.2	+0.2
					U_s Statistic	*	*	*	*	2
	Final	6	20,685	3/1/69	Untreated	5.4	1.7	1.4	1.1	1.0
				2/27/69	Treated	4.8	1.4	1.2	1.0	0.8
					Net Change	-0.6	-0.3	-0.2	-0.1	-0.2
					U_s Statistic	*	*	*	*	*

---

*U_s greater than 2, no statistical difference apparent

TABLE 10. OVERALL SUMMARY OF SMOKE EVALUATIONS, ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL
(Bus 678)

Constant Speed (All open rack--maximum power output)

Vehicle Speed, mph	Test Date	Test Months	Test Miles	Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
				Untreated	Treated	
20	8/20,21/68	0	0	18.0	19.6	(1.6)*
	11/18,19/68	3	7,531	14.3	14.0	0.3
	2/27/69,3/3/69	6	20,685	19.0	16.3	2.7
25	8/20,21/68	0	0	11.0	13.3	(2.3)
	11/18,19/68	3	7,531	10.3	10.3	0
	2/27/69,3/3/69	6	20,685	15.0	11.0	4.0
30	8/20,21/68	0	0	9.7	12.3	(2.6)
	11/18,19/68	3	7,531	9.0	10.3	(1.3)
	2/27/69,3/3/69	6	20,685	13.7	8.7	5.0
35	8/20,21/68	0	0	8.0	10.7	(2.7)
	11/18,19/68	3	7,531	7.2	9.3	(2.1)
	2/27/69,3/3/69	6	20,685	12.0	8.7	3.3

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Test Date	Test Months	Test Miles	Average PHS Smoke Readings, Percent Opacity		Smoke Reduction, Percent Opacity
				Untreated	Treated	
Engine Start	8/20,21/68	0	0	9.7	9.3	0.4
	11/18,19/68	3	7,531	8.3	9.3	(1.0)
	2/27/69,3/3/69	6	20,685	11.0	10.0	1.0
During Acceleration	8/20,21/68	0	0	8.3	8.7	(0.4)
	11/18,19/68	3	7,531	6.7	6.3	0.4
	2/27/69,3/3/69	6	20,685	10.3	7.0	2.3
After Upshift	8/20,21/68	0	0	9.3	10.3	(1.0)
	11/18,19/68	3	7,531	8.3	8.7	(0.4)
	2/27/69,3/3/69	6	20,685	11.3	6.7	4.6

---

*( ) indicates increase in smoke with additive-treated fuel.

TABLE 11. SUMMARY OF AVERAGE "AS-MEASURED" EXHAUST EMISSIONS MEASUREMENTS ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL
(Bus 678)

Operating Conditions	Test Date	Test Months	Test Miles	Test Fuel	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm NO_2	NO, ppm
20 mph 40 hp	8/22/68	0	0	Untreated	1280	5.25	1625	4	43	19	912	
	8/19/68			Treated	1310	4.25	1509	6	42	24	829	
				U_s Statistic	*	0		0	*	0	0	
	3/3/69	6	20,685	Untreated	1189	4.60	1763	3	31	11	747	743
	2/27/69			Treated	1540	5.10	1676	4	34	15	785	848
				U_s Statistic	*	*	0	0	2	0.5	*	1.5
30 mph 40 hp	8/22/68	0	0	Untreated	300	4.55	1555	3	35	20	739	
	8/19/68			Treated	363	3.93	1481	4	33	18	742	
				U_s Statistic	2	0		0	0	0	*	
	3/3/69	6	20,685	Untreated	255	3.50	1700	2	25	6	609	610
	2/27/69			Treated	298	4.00	1589	3	30	10	756	745
				U_s Statistic	1	2	0	0	1	0	0.5	0
40 mph 40 hp	8/22/69	0	0	Untreated	220	4.36	1485	2	31	19	632	
	8/19/68			Treated	258	3.86	1408	2	29	16	701	
				U_s Statistic	0	0		*	*	*	0	
	3/3/69	6	20,685	Untreated	209	3.40	1584	2	21	10	591	550
	2/27/69			Treated	219	3.80	1438	2	25	9	707	670
				U_s Statistic	*	*	0	*	*	*	0	0
Idle	8/22/68	0	0	Untreated	255	1.49	620	2	26	14	280	
	8/19/68			Treated	290	1.45	708	3	25	13	314	
				U_s Statistic	*	*		0	2	*	1	
	3/3/69	6	20,685	Untreated	248	0.80	603	3	23	10	248	186
	2/27/69			Treated	235	0.90	528	3	27	14	254	280
				U_s Statistic	*	1.5	0	*	1	0	*	[illegible]

---

*U_s statistic greater than 2, no statistical difference apparent.

TABLE 12. OVERALL SUMMARY OF ODOR EVALUATIONS, ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL

(Bus 680)

Operating Conditions	Inspection Period	Test Months	Test Miles	Test Date	Test Fuel†	Average Odor Panel Response									
						"D" Composite		"B" Burnt-Smoky		"O" Oily		"A" Aromatic		"P" Pungent	
						EM-73-F	EM-70-F	EM-73-F	EM-70-F	EM-73-F	EM-70-F	EM-73-F	EM-70-F	EM-73-F	EM-70-F
20 mph 40 hp	Initial	0	0	8/29,30/68	Untreated	6.4	6.2	2.1	2.0	1.9	1.9	1.0	1.1	1.7	1.5
				8/28/68	Treated	6.3	6.3	2.0	2.0	1.8	1.8	0.9	0.9	1.3	1.3
					Net Change	-0.1	+0.1	-0.1	0	-0.1	-0.1	-0.1	-0.2	-0.4	-0.2
					U_s Statistic	*	*	*	*	*	*	*	*	1	*
	Interim	3	9,678	11/22/68	Untreated	6.1		2.0		1.6		1.1		1.1	
				11/21/68	Treated	6.1		1.9		1.5		1.3		1.1	
					Net Change	0		-0.1		-0.1		+0.2		0	
					U_s Statistic	*		*		*		*		*	
	Final	6	17,690	3/5/69	Untreated	5.8		1.8		1.2		1.1		1.1	
				3/4/69	Treated	5.7		1.8		1.5		1.2		1.0	
					Net Change	-0.1		0		+0.3		+0.1		-0.1	
					U_s Statistic	*		*		1		*		2	
30 mph 40 hp	Initial	0	0	8/29,30/68	Untreated	This condition not run during initial tests									
				8/28/69	Treated										
					Net Change										
					U_s Statistic										
	Interim	3	9,678	11/22/68	Untreated	5.6		1.8		1.5		1.0		1.0	
				11/21/68	Treated	5.8		1.8		1.5		1.1		1.0	
					Net Change	+0.2		0		0		+0.1		0	
					U_s Statistic	*		*		*		*		*	
	Final	6	17,690	3/5/69	Untreated	5.1		1.4		1.2		1.0		0.7	
				3/4/69	Treated	5.0		1.5		1.3		1.0		0.9	
					Net Change	-0.1		+0.1		+0.1		0		+0.2	
					U_s Statistic	*		*		*		*		*	
40 mph 40 hp	Initial	0	0	8/29,30/68	Untreated	6.3	5.8	2.0	1.9	1.9	1.8	1.0	0.9	1.3	1.2
				8/28/68	Treated	6.0	6.0	1.8	1.8	1.6	1.6	1.0	1.0	1.1	1.1
					Net Change	-0.3	+0.2	-0.2	-0.1	-0.3	-0.2	0	+0.1	-0.2	-0.1
					U_s Statistical	*	*	*	*	*	*	*	*	*	*
	Interim	3	9,678	11/22/68	Untreated	5.7		1.7		1.6		1.1		0.9	
				11/21/68	Treated	5.5		1.6		1.4		1.0		1.1	
					Net Change	-0.2		-0.1		-0.2	–	-0.1		+0.2	
					U_s Statistic	*		*		*		*		*	
	Final	6	17,690	3/5/69	Untreated	5.1		1.4		1.1		1.0		0.8	
				3/4/69	Treated	5.4		1.6		1.5		1.1		1.0	
					Net Change	+0.3		+0.2		+0.4		+0.1		+0.2	
					U_s Statistical	*		*		2		*		1	
Idle	Initial	0	0	8/29,30/68	Untreated	6.4	5.4	2.0	1.9	1.6	1.6	1.1	1.1	1.3	0.8
				8/28/68	Treated	5.7	5.7	1.8	1.8	1.5	1.5	1.1	1.1	1.0	1.0
					Net Change	-0.7	+0.3	-0.2	-0.1	-0.1	-0.1	0	0	-0.3	+0.2
					U_s Statistic	*	*	*	*	*	*	*	*	*	*
	Interim	3	9,678	11/22/68	Untreated	5.8		1.8		1.4		1.1		1.1	
				11/21/68	Treated	6.2		1.9		1.6		1.4		1.2	
					Net Change	+0.4		+0.1		+0.2		+0.3		+0.1	
					U_s Statistical	*		*		*		2		*	
	Final	6	17,690	3/5/69	Untreated	5.6		1.8		1.2		1.1		1.0	
				3/4/69	Treated	6.4		2.1		1.8		1.5		1.1	
					Net Change	+0.8		+0.3		+0.6		+0.4		+0.1	
					U_s Statistic	1.5		2		0		0		1	
Idle-Acceleration	Initial	0	0	8/29,30/68	Untreated	6.3	6.0	2.1	2.0	2.0	1.7	0.9	0.9	1.5	1.4
				8/28/68	Treated	6.4	6.4	1.9	1.9	1.8	1.8	0.9	0.9	1.2	1.2
					Net Change	+0.1	+0.4	-0.2	-0.1	-0.2	+0.1	0	0	-0.3	-0.2
					U_s Statistical	*	*	2	*	1	*	*	*	*	*
	Interim	3	9,678	11/22/68	Untreated	6.5		2.1		1.7		1.2		1.1	
				11/21/68	Treated	5.9		1.9		1.6		1.2		1.1	
					Net Change	-0.6		-0.2		-0.1		0		0	
					U_s Statistic	1.5		1.5		*		*		*	
	Final	6	17,690	3/5/69	Untreated	6.1		1.9		1.7		1.2		1.1	
				3/4/69	Treated	6.3		2.1		1.9		1.2		1.3	
					Net Change	+0.2		+0.2		+0.2		0		+0.2	
					U_s Statistical	*		*		*		*		0	
Deceleration	Initial	0	0	8/29,30/68	Untreated	6.1	6.1	2.0	2.0	1.9	1.8	1.0	1.1	1.3	1.3
				8/28/68	Treated	6.2	6.2	1.9	1.9	1.7	1.7	1.0	1.0	1.2	1.2
					Net Change	+0.1	+0.1	-0.1	-0.1	-0.2	-0.1	0	-0.1	-0.1	-0.1
					U_s Statistic	*	*	1.5	*	*	*	*	*	*	*
	Interim	3	9,678	11/22/68	Untreated	6.0		1.7		1.6		1.1		1.2	
				11/21/68	Treated	5.8		1.8		1.6		1.1		1.1	
					Net Change	-0.2		+0.1		0		0		-0.1	
					U_s Statistical	*		*		*		*		*	
	Final	6	17,690	3/5/69	Untreated	5.7		1.8		1.5		1.3		1.0	
				3/4/69	Treated	5.7		1.9		1.7		1.2		1.0	
					Net Change	0		+0.1		+0.2		-0.1		0	
					U_s Statistic	*		*		*		*		*	

---

*U_s greater than 2, no statistical difference apparent.

†Fuel Code: EM-70-F--SwRI No. 1 Diesel Fuel (kerosene) untreated.
EM-73-F--San Antonio Transit System No. 1 Diesel Fuel (kerosene) untreated.
EM-72-F--EM-73-F plus odor additive.

TABLE 13. OVERALL SUMMARY OF SMOKE EVALUATIONS, ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL
(Bus 680)

Constant Speed (All open rack--maximum power output)

				Average PHS Smoke Reading, Percent Opacity			
				Untreated*		Treated	
Vehicle Speed, mph	Test Date	Test Months	Test Miles	EM-70-F	EM-73-F	EM-72-F	Smoke Reduction, Percent Opacity
20	8/28,29/68	0	0	12.3		10.3	2.0
	8/28,30/68	0	0		13.3	10.3	3.0
	11/21,22/68	3	9,678		10.0	11.3	(1.3)†
	3/4,5/69	6	17,690		10.3	9.0	1.3
25	8/28,29/68	0	0	10.0		8.3	1.7
	8/28,30/68	0	0		10.3	8.3	2.0
	11/21/22/68	3	9,678		7.0	8.7	(1.7)
	3/4,5/69	6	17,690		8.0	7.0	1.0
30	8/28 29/68	0	0	8.7		7.0	1.7
	8/28,30/68	0	0		8.7	7.0	1.7
	11/21,22/68	3	9,678		6.3	8.3	(2.0)
	3/4,5/69	6	17,690		6.0	6.0	0
35	8/28,29/68	0	0	7.0		6.0	1.0
	8/28,30/68	0	0		7.3	6.0	1.3
	11/21,22/68	3	9,678		5.7	7.3	(1.6)
	3/4,5/69	6	17,690		5.0	4.3	0.7

Idle-Acceleration (40 hp at 30 mph preset and retained)

				Average PHS Smoke Reading, Percent Opacity			
Portion of Idle-Acceleration	Test Date	Test Months	Test Miles	SwRI	S. A. Transit	Additive	Smoke Reduction, Percent Opacity
Engine Start	8/28,29/68	0	0	7.0		9.7	(2.7)
	8/28,30/68	0	0		7.3	9.7	(2.4)
	11/21,22,68	3	9,678		6.3	6.7	(0.4)
	3/4,5/69	6	17,690		7.0	5.3	1.7
During Acceleration	8/28,29/68	0	0	6.0		5.7	0.3
	8/28,30/68	0	0		7.0	5.7	1.3
	11/21,22/68	3	9,678		3.3	3.3	0
	3/4,5/69	6	17,690		4.3	5.3	(1.0)
After Upshift	8/28,29	0	0	7.0		6.0	1.0
	8/28,30/68	0	0		7.7	6.0	1.7
	11/21,22/68	3	9,678		5.0	5.0	0
	3/4,5/69	6	17,690		6.0	5.3	0.7

---

*EM-73-F is untreated San Antonio Transit fuel (No. 1 kerosene). EM-91-F is EM-73-F treated at manufacturer's recommended dose. EM-92-F is EM-73-F treated at twice the manufacturer's recommended dose. EM-93-F is EM-73-F treated at three times the manufacturer's recommended dose.

†( ) indicates increase in smoke with additive-treated fuel.

TABLE 14. SUMMARY OF AVERAGE "AS-MEASURED" EXHAUST EMISSIONS MEASUREMENTS ADDITIVE-TREATED FUEL VS UNTREATED BASE FUEL

(Bus 680)

Condition	Test Date	Test Months	Test Miles	Fuel	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
20 mph	8/30/68	0	0	EM-73-F	1388	4.06	1890	3	30	13	756	
40 hp	8/27/68			EM-72-F	1463	4.14	1906	4	40	22	779	
				U_s Statistic	*	*	*	*	2	0	1	
	9/4/68			EM-70-F	1710	4.7	1983	5	36	18	687	
	8/27/68			EM-72-F	1463	4.14	1906	4	40	22	779	
				U_s Statistic	*	0	*	*	*	*	0	
	3/5/69	6	17,690	EM-73-F	2204	4.9	1856	6	42	26	805	690
	3/4/69			EM-72-F	1955	4.7	1758	5	38	18	779	831
				U_s Statistic	*	*	*	0	*	0	*	0
30 mph	8/30/68	0	0	EM-73-F	305	3.49	1948	3	28	12	669	
40 hp	8/27/68			EM-72-F	273	3.70	1993	3	30	16	730	
				U_s Statistic	1	*	*	2	*	0	0	
	9/4/68			EM-70-F	315	4.19	2010	3	33	17	675	
	8/27/68			EM-72-F	273	3.70	1993	3	30	16	730	
				U_s Statistic	1	0	*	*	*	*	0	
	3/5/69	6	17,690	EM-73-F	304	3.9	1746	3	28	15	788	680
	3/4/69			EM-72-F	281	3.9	1723	4	34	15	843	805
				U_s Statistic	*	*	*	*	*	*	*	0
40 mph	8/30/68	0	0	EM-73-F	258	3.45	1863	2	34	13	638	
40 hp	8/27/68			EM-72-F	246	3.65	1904	4	29	16	649	
				U_s Statistic	*	*	*	1	0	*	*	
	9/4/68			EM-70-F	256	4.15	1333	2	29	13	594	
	8/27/68			EM-72-F	246	3.65	1904	4	29	16	649	
				U_s Statistic	*	0	*	1	*	*	0	
	3/5/69	6	17,690	EM-73-F	225	3.8	1584	4	27	21	623	623
	3/4/69			EM-72-F	218	3.8	1589	3	34	15	834	728
				U_s Statistic	*	*	*	0.5	1	1	0	0.5
Idle	8/30/68	0	0	EM-73-F	263	0.98	1028	5	27	11	259	
	8/27/68			EM-72-F	243	1.05	1496	3	37	23	285	
				U_s Statistic	*	*	0	0	*	1	0.5	
	9/4/68			EM-70-F	235	1.10	1063	4	26	21	268	
	8/27/68			EM-72-F	243	1.05	1496	3	37	23	285	
				U_s Statistic	*	*	0	*	*	*	0.5	
	3/5/69	6	17,690	EM-73-F	313	0.9	1966	5	57	23	277	210
	3/4/69			EM-72-F	313	0.9	2239	6	46	19	298	265
				U_s Statistic	*	*	*	*	0	1	*	0

---

*U_s greater than 2, no statistical difference apparent.

TABLE 15. EFFECT OF ADDITIVE DOSE LEVEL ON PERCEIVED ODOR

(Bus 676)

Operating Condition	Date	Fuel Code*	Average Odor Panel Response					
			"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent	Cumulative "D", "B", "O", "A", "P"
20 mph	2/21/69	EM-73-F	5.6	1.4	1.3	1.1	1.0	10.4
40 hp	2/24/69	EM-91-F	5.2	1.4	1.1	1.0	1.0	9.7
	2/25/69	EM-92-F	5.4	1.3	1.2	1.1	0.9	9.7
	2/26/69	EM-93-F	5.1	1.4	1.3	1.1	0.9	9.8
30 mph	2/21/69	EM-73-F	5.6	1.5	1.4	1.1	1.0	10.6
40 hp	2/24/69	EM-91-F	5.5	1.6	1.2	1.0	1.0	10.3
	2/25/69	EM-92-F	5.4	1.4	1.2	1.2	0.8	10.0
	2/26/69	EM-93-F	5.1	1.4	1.2	1.1	0.9	9.7
40 mph	2/21/69	EM-73-F	6.0	1.9	1.5	1.2	1.0	11.6
40 hp	2/24/69	EM-91-F	5.7	1.6	1.4	1.1	1.0	10.8
	2/25/69	EM-92-F	5.5	1.3	1.3	1.1	0.8	10.0
	2/26/69	EM-93-F	5.0	1.3	1.3	1.0	0.9	9.5
Idle	2/21/69	EM-73-F	6.0	1.8	1.6	1.2	1.0	11.6
	2/24/69	EM-91-F	5.6	1.7	1.3	1.2	1.0	10.8
	2/25/69	EM-92-F	5.8	1.7	1.4	1.3	0.9	11.1
	2/26/69	EM-93-F	5.4	1.7	1.5	1.1	0.9	10.6
Idle-Acceleration	2/21/69	EM-73-F	6.1	1.9	1.8	1.1	1.1	12.0
	2/24/69	EM-91-F	6.5	2.1	1.9	1.2	1.2	12.9
	2/25/69	EM-92-F	6.6	2.0	1.9	1.2	1.1	12.8
	2/26/69	EM-9[illegible]-F	6.3	1.8	1.9	1.3	1.2	12.5
Deceleration	2/21/69	EM-73-F	5.0	1.4	1.2	1.1	0.9	9.6
	2/24/69	EM-91-F	5.2	1.6	1.3	1.1	1.0	10.2
	2/25/69	EM-92-F	5.0	1.4	1.3	1.1	0.8	9.6
	2/26/69	EM-93-F	4.7	1.2	1.3	1.0	0.8	9.0

---

*EM-73-F is untreated San Antonio Transit fuel (No. 1 kerosene). EM-91-F is EM-73-F treated at manufacturer's recommended dose. EM-92-F is EM-73-F treated at twice the manufacturer's recommended dose. EM-93-F is EM-73-F treated at three times the manufacturer's recommended dose.

TABLE 16. EFFECT OF ADDITIVE BASE LEVEL ON SAMPLE
(Bus 676)

Constant Speed Results (All open rack-maximum output)

Date	Fuel Code*	Vehicle Speed, mph	Load hp	PHS Smoke Readings, Percent Opacity		
				Max	Min	Avg
2/21/69	EM-73-F	20	47	8	8	8.0
2/24/69	EM-91-F		48	9	8	8.7
2/25/69	EM-92-F		46	8	7	7.7
2/26/69	EM-93-F			9	8	8.7
2/21/69	EM-73-F	25	61	6	6	6.0
2/24/69	EM-91-F		60	8	7	7.3
2/25/69	EM-92-F		54	6	6	6.0
2/26/69	EM-93-F			7	6	6.7
2/21/69	EM-73-F	30	73	6	6	6.0
2/24/69	EM-91-F		75	7	6	6.7
2/25/69	EM-92-F		70	6	6	6.0
2/26/69	EM-93-F			7	6	6.3
2/21/69	EM-73-F	35	86	6	5	5.3
2/24/69	EM-91-F		86	6	6	6.0
2/25/69	EM-92-F		82	6	5	5.7
2/26/69	EM-93-F			6	6	6.0

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Date	Fuel Code	PHS Smoke Reading, Smoke Opacity		
			Max	Min	Avg
Start of Engine	2/21/69	EM-73-F	15	14	14.3
	2/24/69	EM-91-F	15	14	14.3
	2/25/69	EM-92-F	12	10	11.3
	2/26/69	EM-93-F	14	12	13.0
During Acceleration	2/21/69	EM-73-F	6	6	6.0
	2/24/69	EM-91-F	9	8	8.7
	2/25/69	EM-92-F	8	6	7.0
	2/26/69	EM-93-F	8	7	7.3
After Upshift	2/21/69	EM-73-F	6	5	5.3
	2/24/69	EM-91-F	7	6	6.7
	2/25/69	EM-92-F	5	5	5.0
	2/26/69	EM-93-F	6	6	6.0

---

*EM-73-F is untreated San Antonio Transit Fuel (No. 1 kerosene). EM-91-F is EM-73-F treated at manufacturer's recommended dose. EM-92-F is EM-73-F treated at twice the manufacturer's recommended dose. EM-93-F is EM-73-F treated at three times the manufacturer's recommended dose.

similar group of three buses powered by the same type engines and operated similarly are also listed for comparison purposes.

From the standpoint of technical effectiveness, however, the 6-month test failed to demonstrate consistent gross improvement that would justify its use, almost regardless of cost. The effectiveness, according to the trained sensory panel rating odor by the PHS Q/I kit and smoke and other emissions, was nil. The reductions in, for example, the "D" rating, the most important indicator of diesel exhaust odor intensity, were so scattered and small that it was not possible to determine an average "D" improvement. The same was true for "B," "O," "A," and "P," ratings, especially when these ratings were sometimes about the same or higher than the base fuel. From an engineering standpoint, the technical effectiveness of the odor additive must be adjudged zero or very close to zero. Division of the $0.000426/gal cost by zero or any value approaching zero effectiveness results in an extremely high cost-effectiveness ratio.

IV. FLEET TEST OF CATALYTIC MUFFLER

The intent of this phase is to determine the potentialities of a catalytic type converter for reduction of odor and other emissions and, by means of a fleet test, establish their cost effectiveness. Additional catalytic devices had become available during six months between the Part II evaluations and the start of Part III, necessitating additional screening tests.

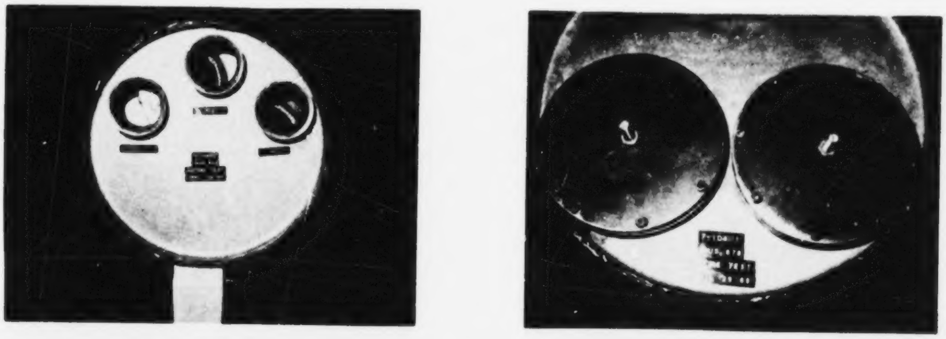
A. Screening Tests - Initial

Three catalyst devices were evaluated during the initial screening tests to select one for fleet test.

1. Description of Devices

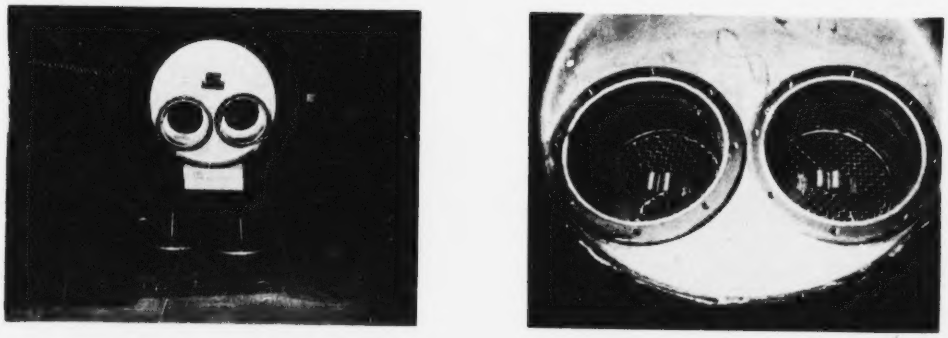
The first type of reactor evaluated, known as Code "Z," was housed in the usual stock muffler and possessed sound suppression characteristics similar to the stock unit. This catalytic muffler was provided in two versions coded "Z"-1 and "Z"-2, both employing the same catalyst material but with different fixed substrate geometry. These mufflers, of experimental design, were supplied by a manufacturer who prepared the substrate, or media, on which the catalyst was applied and made use of the standard stock muffler for a housing. As a result, this muffler was capable of being mounted under the coach in place of the stock unit.

Several views of the Code "Z" catalytic muffler are shown on Figure 21 and indicate the basic configuration of the device. It may be noted that on the normally blank end of the stock muffler, access openings were added to permit installation and removal of the catalyst cartridges and also to permit inspection. The muffler coded "Z"-1 contained four cartridges of catalyst coated substrate utilizing a 3/16-inch straight cell honeycomb design.



Exhaust Inlets/Outlet

Catalyst Access Covers



Catalyst Covers and Retaining Screen Removed

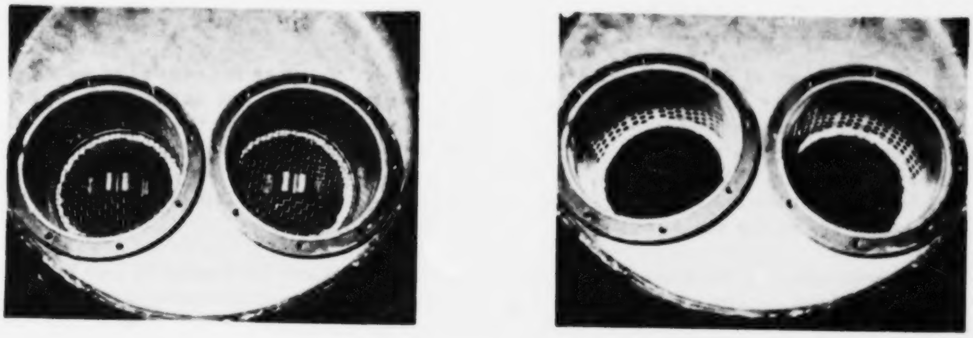
Access Covers Removed

FIGURE 21. CODE "Z" CATALYTIC MUFFLER GENERAL CONFIGURATION

The test and evaluation of each of the "Z" type mufflers were conducted after approximately 30 days of routine operation on a San Antonio Transit bus powered by an E type Detroit Diesel 6V-71 two-valve engine. As the two versions of the "Z" muffler made use of the same catalyst material, it was decided to conduct the performance and evaluation inspection on the same bus. Accordingly, Bus 678 was used to not only accumulate vehicle operation with "Z"-1 but also to evaluate performance of "Z"-2 which was installed on Bus 680. These two buses were selected on the basis of the ten-bus variability program conducted during Part I as having representative odor and smoke characteristics.

Shown on Figure 22 are several photographs taken "before" and "after" operation of "Z"-1. The lower photographs show some of the honeycomb catalyst substrate cartridges and their relative

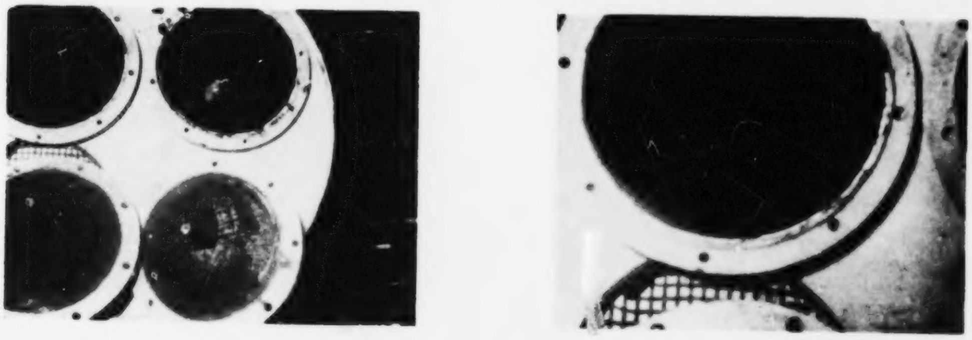
Before Test (0 Miles)



Catalyst Access Covers Removed

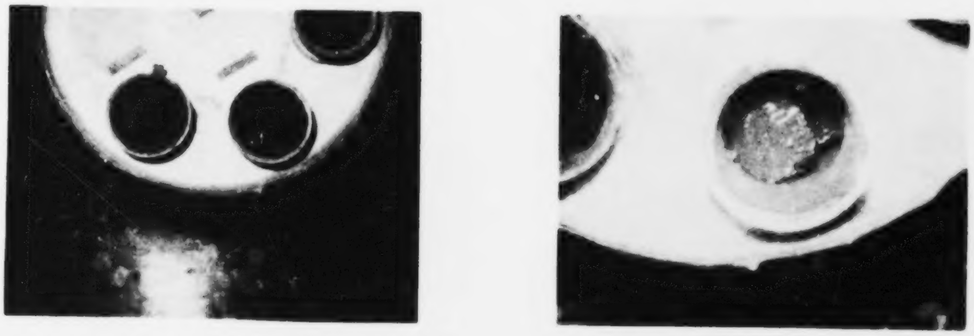
Catalyst Retaining Screen Removed

After Test (3087 Miles)



Access Covers Removed

Interior View of Catalyst



Exhaust Inlets to Catalyst

Catalyst Substrate Section

FIGURE 22. CODE "Z"-1 CATALYTIC MUFFLER BEFORE AND AFTER TEST

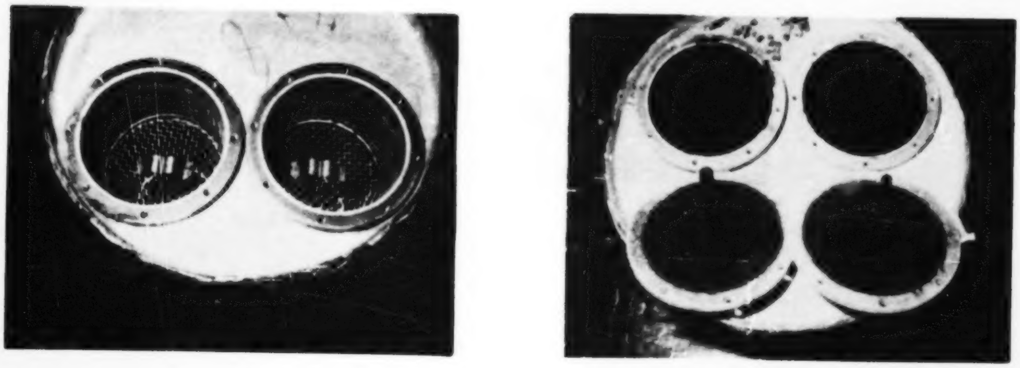
position after completion of the test. The "after" photographs show an accumulation of smoke and carbon particulate in the access areas, in which the gases exiting the catalyst reverse direction (upper two photographs, Figure 22). The lower two photographs show the position of the cartridges which were dislocated some time during vehicle operation and were found as shown in the inlet area to the muffler. The loose cartridge sections were not discovered until the mileage accumulation and emissions tests were completed. Movement of the cartridges apparently was caused by an inadequate retaining ring.

Shown in Figure 23 are "before" and "after" test views of "Z"-2. This unit utilized only two cartridges of catalyst-coated substrate and involved crossflow cells of 3/8-inch pore size. An indication of the substrate configuration may be noted in the lower left photograph of Figure 23. Except for the crossflow configuration of the substrate media and the enlarged cell size, "Z"-2 and its catalyst coating was reported to be essentially identical to "Z"-1. Smoke particulate and other debris were found in the access area after test as shown in the two photographs on the right side of Figure 23. Although one retaining screen had moved from its normal position, the catalyst substrate appeared intact. The photographs taken of both mufflers were obtained by removing the access covers and retaining screens. At no time was the catalytic material or substrate removed or relocated, and the "after" photographs were taken without disturbing the interior of the devices.

The other type of reactor evaluated, known as Code "W" and shown in Figure 24, was not available in a configuration suitable for simple installation. As a result, this unit was evaluated in its as-received new condition.

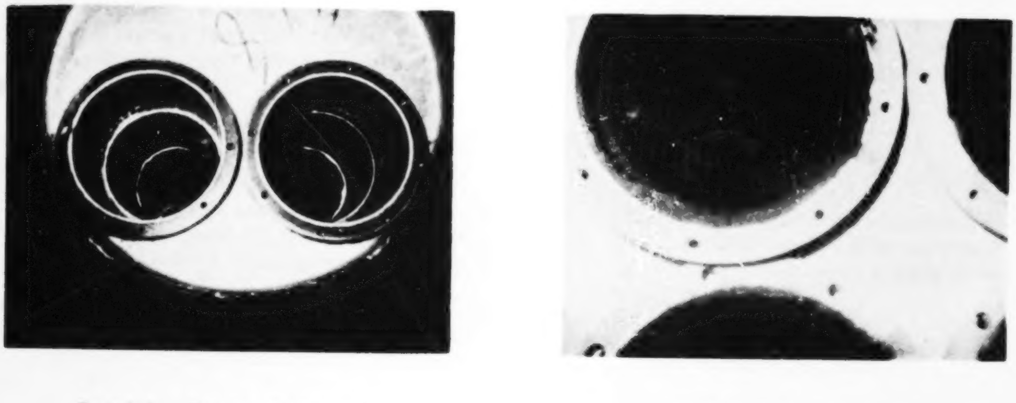
Before Test (0 Miles)

After Test (2437 Miles)



Access Covers Removed

Access Covers Removed



Retaining Screen Removed

Catalyst Location

FIGURE 23. CODE "Z"-2 CATALYTIC MUFFLER BEFORE AND AFTER TEST

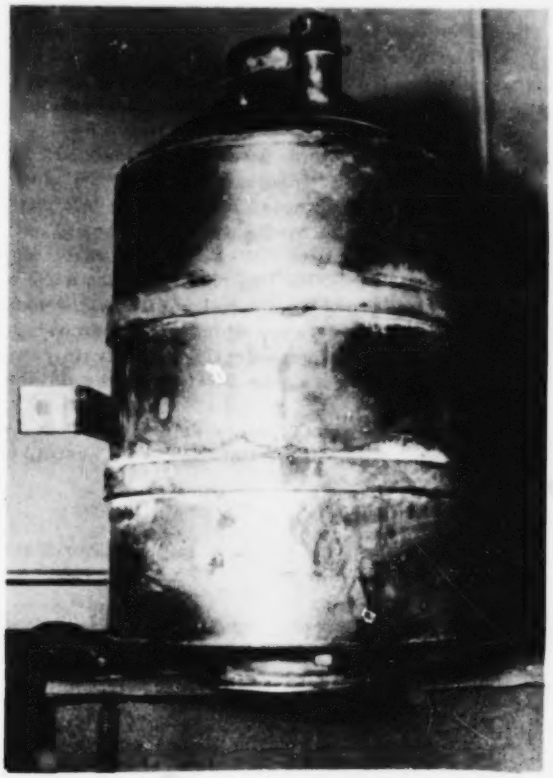


FIGURE 24. CODE "W" CATALYTIC MUFFLER

2. Results of Initial Screening Tests

Each of the three catalytic reactors was subjected to back-to-back type evaluations. The units were operated on Bus 678 on the chassis dynamometer, and odor, smoke, CO, CO_2, acrolein, formaldehyde, aldehydes, nitrogen oxides, and muffler inlet and outlet temperatures and pressures were obtained under a variety of operating conditions. The catalytic muffler was then removed, the stock muffler installed, and a similar series of measurements was obtained. Odor was measured on two successive days with the catalytic muffler and then with the stock muffler to facilitate direct comparison. The operating conditions for measurement of odor, smoke, and other emissions, as well as pressures, temperatures, and general performance, are described in detail in the first fourteen tables of Appendix B.

a. Code "Z" Catalytic Muffler Evaluation Results

Because of the similarities of the two "Z" mufflers, the results have been summarized and presented where possible on the same table to facilitate comparison with the standard muffler, as well as with each other. Muffler "Z"-1 was operated for a period of 35 days, during which time 3087 miles were accumulated. "Z"-2 operated for 32 days and accumulated 2437 miles.

An overall summary of the effect of the "Z" type muffler on exhaust odor, relative to that with the stock muffler, may be found on Table 17 of the text. For each set of stock and catalytic ratings, the difference is shown by the net change in which plus values indicate an increase and minus values represent a decrease in the perceived odor intensity due to the "Z" muffler. The "U_s" statistical test results indicate "Z"-2 to be slightly more effective than "Z"-1 relative to the stock muffler. Interpretation of the "U_s" statistic is important. For example, the 20-mph "D" rating was 6.3 with the stock and 6.5 with "Z"-1. Although a statistical difference was indicated for these two sets of measurements ("U_s" = 1.5), the interpretation of the difference would be that the "Z" muffler had no real effect

TABLE 17. OVERALL SUMMARY OF ODOR EVALUATION CATALYTIC MUFFLER CODE "Z" VS STOCK MUFFLER

Vehicle: Bus 678

Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Days	Test Miles	Muffler Code	Average Odor Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph 40 hp	6/6/68 6/5/68	35	3087	Stock	6.3	2.1	1.9	1.1	1.2
				"Z"-1	6.8	1.8	1.8	1.2	1.0
				Net Change	+0.5	-0.3	-0.1	+0.1	-0.2
				U_s Statistic	1.5	1	*	*	*
	6/10/68 6/11/68	32	2437	Stock	5.5	2.0	1.5	0.9	1.0
				"Z"-2	6.8	2.1	1.9	1.4	1.2
				Net Change	+1.3	+0.1	+0.4	+0.5	+0.2
				U_s Statistic	0	*	0	0	2
40 mph 40 hp	6/6/68 6/5/68	35	3087	Stock	7.2	2.4	2.0	1.2	1.4
				"Z"-1	6.8	2.0	1.8	1.4	1.1
				Net Change	-0.4	-0.4	-0.2	+0.2	-0.3
				U_s Statistic	*	1.5	*	*	*
	6/10/68 6/11/68	32	2437	Stock	6.9	1.9	1.7	1.2	1.2
				"Z"-2	6.6	2.1	1.9	1.3	1.1
				Net Change	-0.3	+0.2	+0.2	+0.1	-0.1
				U_s Statistic	*	*	*	*	*
Idle	6/6/68 6/5/68	35	3087	Stock	5.7	1.8	1.5	1.5	0.7
				"Z"-1	5.6	1.5	1.1	1.3	0.4
				Net Change	-0.1	-0.3	-0.4	-0.2	-0.3
				U_s Statistic	*	*	*	*	*
	6/10/68 6/11/68	32	2437	Stock	6.0	1.8	1.5	1.1	0.9
				"Z"-2	5.0	1.4	1.1	1.0	0.5
				Net Change	-1.0	-0.4	-0.4	-0.1	-0.4
				U_s Statistic	1.5	1	*	*	*
Idle-Acceleration	6/6/68 6/5/68	35	3087	Stock	6.8	2.0	1.9	1.1	1.4
				"Z"-1	7.3	2.0	2.0	1.3	1.4
				Net Change	-0.5	0	+0.1	+0.2	0
				U_s Statistic	*	*	*	*	*
	6/10/68 6/11/68	32	2437	Stock	7.3	2.1	2.0	1.3	1.6
				"Z"-2	6.5	2.1	1.9	1.2	1.1
				Net Change	-0.8	0	-0.1	-0.1	-0.5
				U_s Statistics	1	*	*	*	0
Deceleration	6/6/68 6/5/68	35	3087	Stock	5.0	1.5	1.2	0.9	0.5
				"Z"-1	5.1	1.3	1.1	1.1	0.5
				Net Change	+0.1	-0.2	-0.1	+0.2	0
				U_s Statistic	*	*	1	*	*
	6/10/68 6/11/68	32	2437	Stock	5.6	1.6	1.2	0.8	0.5
				"Z"-2	5.2	1.6	1.3	1.0	0.7
				Net Change	-0.4	0	+0.1	+0.2	+0.2
				U_s Statistic	*	*	*	*	*

on the "D" rating. A difference of 0.2 in "D" rating is well within the experimental accuracy of the ten-person panel rating method at this "D" level. The bar charts in Figures 25 and 26 show the general lack of a consistent or substantial reduction in odor ratings.

On Table 18, the results of the smoke evaluation are summarized for the stock and both "Z" mufflers. Operating at maximum engine power conditions at 20, 25, 30, and 35 mph, it was found that the "Z" type catalytic reactor had no effect on smoke output as measured by the PHS full-flow, light-extinction smokemeter. Essentially the same conclusion may be stated for the smoke

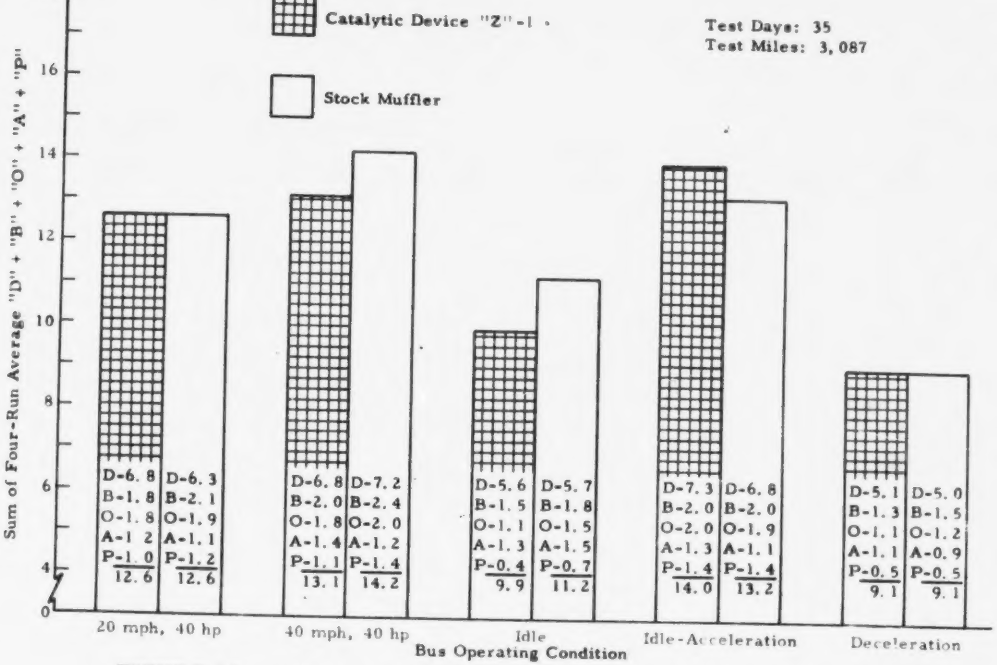


FIGURE 25. OVERALL COMPARISON OF DIESEL ODOR EVALUATION WITH AND WITHOUT CATALYTIC MUFFLER INSTALLED

(Bus 678, Date: June 5 & 6, 1968)

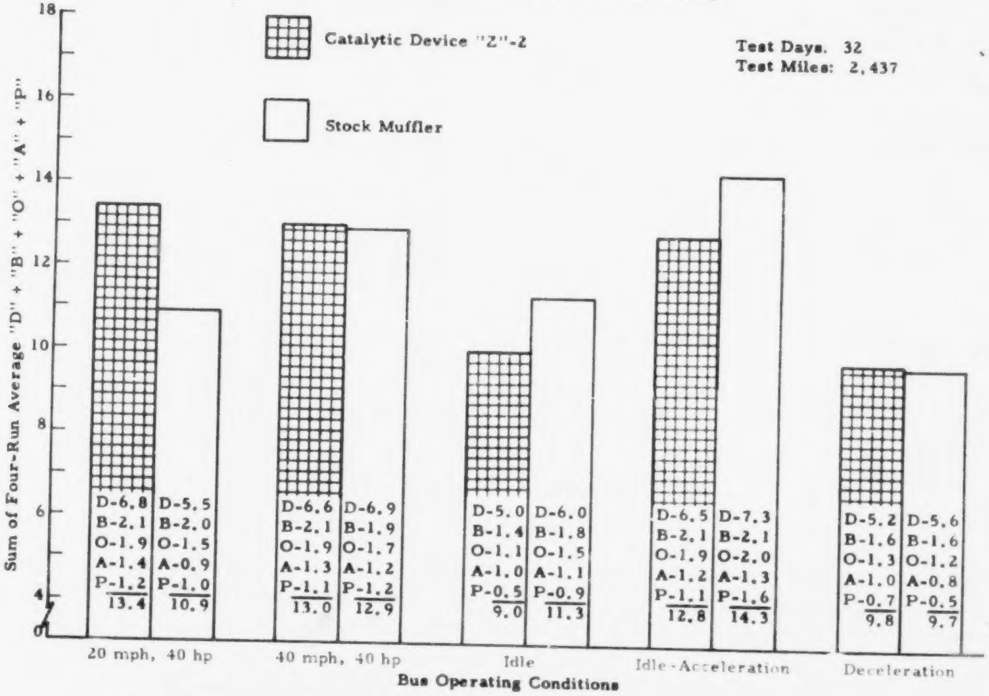


FIGURE 26. OVERALL COMPARISON OF DIESEL ODOR EVALUATION WITH AND WITHOUT CATALYTIC MUFFLER INSTALLED

(Bus 678, Date: June 10 & 11, 1968)

TABLE 18. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "Z" VS STOCK MUFFLER

Fuel: EM-3A-F (No. 1 Diesel)

Constant Speed (All open-rack--maximum power output)

Vehicle Speed, mph	Test Date	Test Days	Test Miles	Average PHS Smoke Reading, Percent Opacity Stock	"Z"-1	"Z"-2	Smoke Reduction, Percent Opacity
20	6/4, 6/68	35	3087	17.0	17.7		(0.7)*
	6/6, 10/68	32	2437	17.0		18.0	(1.0)
25	6/4, 6/68	35	3087	12.0	12.0		0
	6/6, 10/68	32	2437	12.0		11.7	0.3
30	6/4, 6/68	35	3087	11.0	10.7		0.3
	6/6, 10/68	32	2437	11.0		10.0	1.0
35	6/4, 6/68	35	3087	9.3	9.0		0.3
	6/6, 10/68	32	2437	9.3		9.7	(0.4)

Idle-Acceleration (40 hp at 40 mph preset and retained)

Portion of Idle-Acceleration	Test Date	Test Days	Test Miles	Average PHS Smoke Reading, Percent Opacity Stock	"Z"-1	"Z"-2	Smoke Reduction, Percent Opacity
Engine Start	6/4, 6/68	35	3087	9.7	10.3		(0.6)
	6/6, 10/68	32	2437	9.7		9.3	0.4
During Acceleration	6/4, 6/68	35	3087	8.3	7.7		0.6
	6/6, 10/68	32	2437	8.3		9.3	(1.0)
After Upshift	6/4, 6/68	35	3087	8.0	8.0		0
	6/6, 10/68	32	2437	8.0		8.7	(0.7)

*( ) indicates increase in smoke with catalytic muffler installed.

measurements made during vehicle acceleration after engine start and prolonged idle. On Table 19, the exhaust emissions and pressure and temperature measurements for the "Z" and stock units are summarized.

Neither "Z" muffler had a noticeable effect on the exhaust; this was confirmed by the results of the statistical evaluation. Only in two of the fifty-six comparisons did the "Z" device appear to have a beneficial effect.

The lower half of Table 19 gives the average muffler inlet and outlet pressures and temperatures and air box pressures. The "Z"-2 muffler, with the crossflow catalyst substrate design, resulted in about 75 percent more pressure drop than the stock or "Z"-1 straight honeycomb design at 20, 30, and 40 mph. These cruise conditions also resulted in a greater engine air box pressure for "Z"-2. The exhaust inlet and outlet temperatures with "Z"-2 were greater than "Z"-1 and the stock units; this may be attributed to the higher backpressures resulting in possibly less scavenging efficiency. For complete details of the Code "Z" screening tests, please refer to Appendix B, Tables 1 to 30.

b. Code "W" Catalytic Muffler Evaluation Results

Figure 27 shows the Code "W" catalytic muffler under test. The exhaust from three cylinders, the rear bank of the Detroit Diesel 6V-71 E engine in Bus 678, was passed through the "W"

TABLE 19. SUMMARY OF EXHAUST EMISSIONS AND MUFFLER PRESSURE AND TEMPERATURE MEASUREMENTS CATALYTIC MUFFLER CODE "Z" VS STOCK MUFFLER

Vehicle: Bus 678

Fuel: EM-3A-F (No. 1 Diesel)

Average "As-Measured" Exhaust Emissions

Operating Conditions	Test Date	Test Days	Test Miles	Muffler Code	CO, ppm	CO_2, Percent	Acrolein, ppm	Aliphatic Aldenydes*, ppm	Formaldehyde, ppm	NO_x, ppm
20 mph 40 hp	6/7/68			Stock	755	4.11	2.78	33.60	15.83	794
	6/4/68	35	3087	"Z"-1	763	4.35	4.77	31.86	18.18	778
	6/12/68	32	2437	"Z"-2	898	4.75	4.23	38.80	20.55	777
40 mph 40 hp	6/7/68			Stock	181	3.18	1.56	25.38	9.74	601
	6/4/68	35	3087	"Z"-1	185	3.15	2.18	21.83	10.21	570
	6/12/68	32	2437	"Z"-2	186	3.66	1.84	28.34	16.05	589
Idle	6/7/68			Stock	198	0.80	2.70	27.01	11.34	214
	6/4/68	35	3087	"Z"-1	237	0.77	2.96	21.83	10.43	193
	6/12/68	32	2437	"Z"-2	203	0.90	2.77	24.49	11.67	240
30 mph 40 hp	6/7/68			Stock	196	3.29	2.32	28.28	12.66	655
	6/4/68	35	3087	"Z"-1	202	3.26	2.96	23.60	10.88	662
	6/12/68	32	2437	"Z"-2	211	3.78	3.13	33.48	18.02	638

Average Muffler Pressure and Temperature Measurements

Operating Conditions	Test Date	Test Days	Test Miles	Muffler Code	Muffler Pressure, in. Hg			Muffler Temperature, °F			Air Box Pressure, in. Hg
					Inlet	Outlet	Differential	Inlet	Outlet	Differential	
20 mph 40 hp	6/6/68			Stock	0.75	0.30	0.50	427	386	41	1.10
	6/5/68	35	3087	"Z"-1	0.80	0.20	0.60	426	356	71	1.00
	6/10/68			Stock	0.80	0.20	0.60	416	391	26	1.00
	6/11/68	32	2437	"Z"-2	1.10	0.40	0.90	468	442	26	1.50
40 mph 40 hp	6/6/68			Stock	2.90	0.95	1.90	466	426	40	6.00
	6/5/68	35	3087	"Z"-1	3.10	1.30	1.85	471	362	109	6.00
	6/10/68			Stock	2.80	1.30	1.70	455	413	42	5.70
	6/11/68	32	2437	"Z"-2	3.90	1.10	2.90	523	484	39	6.50
Idle	6/6/68			Stock	0.20	0.10	0.10	313	334	(31)	0.80
	6/5/68	35	3087	"Z"-1	0.20	0.10	0.10	262	342	(80)	0.85
	6/10/68			Stock	0.20	0.10	0.10	291	322	(30)	0.80
	6/11/68	32	2437	"Z"-2	0.20	0.10	0.10	323	358	(35)	0.80
30 mph 40 hp	6/6/68			Stock	1.70	0.60	1.10	402	375	27	3.00
	6/5/68	35	3087	"Z"-1	1.85	0.60	1.20	440	361	79	3.00
	6/10/68			Stock	1.60	0.60	1.00	410	361	48	3.00
	6/11/68	32	2437	"Z"-2	2.30	1.70	1.70	408	403	21	3.60

---

*Total as ppm formaldehyde.

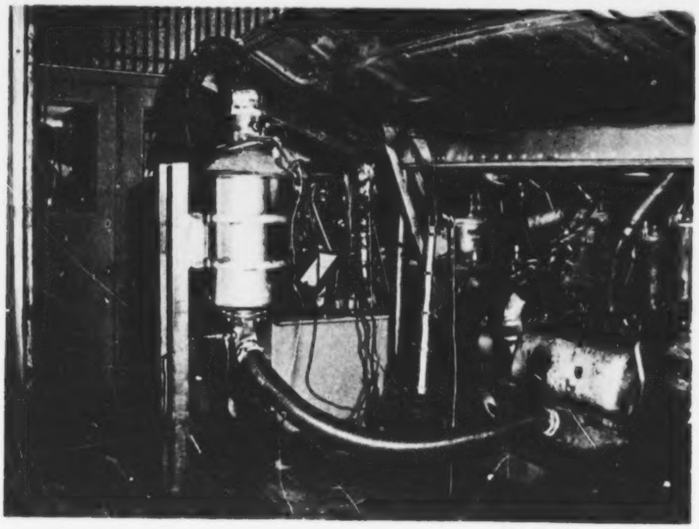


FIGURE 27. CODE "W" CATALYTIC MUFFLER TEST CONFIGURATION

muffler. The exhaust from the front bank was handled as usual by the stock muffler located under the coach. After removing the bumper, the rear exhaust manifold was replaced by the center outlet unit shown to allow simple flexible exhaust pipe connection to the bottom of the vertically mounted "W" muffler. The gases entered into the center of the muffler and then passed through an annular layer of catalyst granules. The gases, then, collect in an outer annular space between the stainless housing and the catalyst and then exit the muffler through the top cone. The exhaust was then directed through the laboratory central exhaust system for odor and other emissions measurements as usual. As this type of catalytic reactor was not available in a configuration suitable for simple bus installation, a unit capable of handling half the engine was obtained and tested in the as-received, new condition.

An overall summary of the back-to-back odor evaluation is shown in Table 20 of the text. The new "W" muffler resulted in significant and consistent reductions under all but the 20-mph, 40-hp cruise. Reductions in the "D" ratings ranging from 0.9 to 0.4 were found during the other four conditions. "B" ratings, the first most obvious, were likewise reduced by 0.4 to 0.8 intensity numbers. These reductions were confirmed by the "U_s" test as indicated in Table 20, and are graphically illustrated in Figure 28.

An analysis of the data was also made to determine if the odor qualities were found to be similar in obviousness to the usual "B," most obvious, "O" or "A," next most obvious, and "P," least obvious. For the first time, the "P" pungent or sourness rating appeared to be more obvious, moving up to third place. "B" still was most obvious although not nearly as predominately as it had previously been. The character of the catalytic exhaust, though lacking the usual diesel-kerosene odor with substantial burnt-smoky quality, was changed sufficiently to allow a somewhat sour, hard to describe odor to be perceived. It may be that removal of some of the predominate odor species allowed

TABLE 20. OVERALL SUMMARY OF ODOR EVALUATION CATALYTIC MUFFLER CODE "W" VS STOCK MUFFLER

Vehicle: Bus 678
Date: June 17 & 18, 1968

Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Test Date	Muffler Code	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
	6/18/68	Stock	6.6	2.0	1.8	1.2	1.2
20 mph	6/17/68	"W"	6.8	2.3	1.8	1.2	1.2
40 hp	Net Change		+0.2	+0.3	0	0	0
	U_s Statistic		*	*	*	*	*
	6/18/68	Stock	7.1	2.2	2.0	1.2	1.4
40 mph	6/17/68	"W"	4.7	1.4	1.3	0.8	0.3
40 hp	Net Change		-2.4	-0.8	-0.7	-0.4	-1.1
	U_s Statistic		0.5	1	1	0	1
	6/18/68	Stock	5.6	1.9	1.6	1.0	0.9
Idle	6/17/68	"W"	3.3	1.0	0.9	0.8	0.2
	Net Change		-2.3	-0.8	-0.7	-0.2	-0.7
	U_s Statistic		0	0	0	1	0
	6/18/68	Stock	8.0	2.5	2.0	1.1	2.0
Idle-	6/17/68	"W"	7.1	2.1	2.0	1.0	1.8
Acceleration	Net Change		-0.9	-0.4	0	-0.1	-0.2
	U_s Statistic		0	0.5	*	*	*
	6/18/68	Stock	5.3	1.8	1.5	1.1	0.9
Deceleration	6/17/68	"W"	4.1	1.1	1.0	0.7	0.2
	Net Change		-1.2	-0.7	-0.5	-0.4	-0.7
	U_s Statistic		0	0	0	0.5	0

---

*U_s greater than 2, no statistical difference apparent.

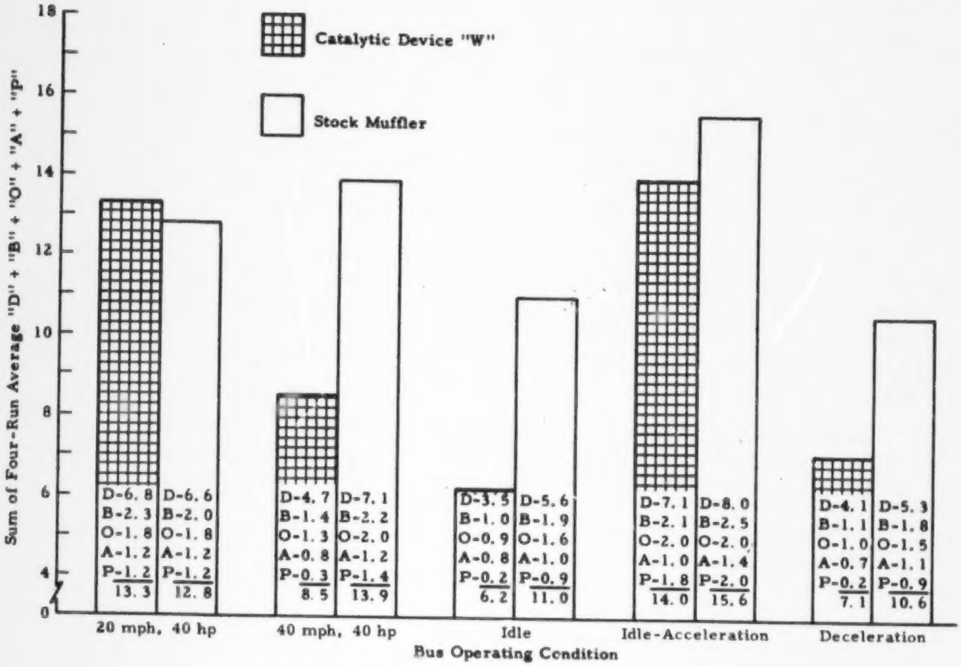


FIGURE 28. OVERALL COMPARISON OF DIESEL ODOR EVALUATION WITH AND WITHOUT CATALYTIC MUFFLER INSTALLED

(Bus 678, Date: June 17 & 18, 1968)

the less perceptible qualities already present to become more noticeable. The panel was asked to compare the 2 days of operation and point out those characteristics of the odor that changed. The replies were unanimous that the runs on June 18 with the stock muffler were much stronger in the characteristic two-cycle diesel odor than those the day before. The stock muffler exhaust was higher in the kerosene smell. The runs with the catalytic device were more mild, with a different, difficult to describe, character.

The "W" muffler also appeared to reduce smoke slightly as shown in Table 21, with the greatest effect noticed under constant speed and maximum power. Whether the muffler catalyst bed was acting as a filter or was converting the carbon particulate is unknown because of the limited test.

Table 22 in the text is a comparison of emissions, pressures, and temperatures for the stock and "W" mufflers. In line with the favorable reductions in odor and smoke, the "W" reactor also had a beneficial effect on the other emissions measured. CO was reduced, as was acrolein, total aldehydes, and formaldehyde. NO_x was about the same or slightly lower. Only two of the twenty-eight comparisons lacked statistical importance; and, in twenty instances, "U_s" equalled zero, indicating the strongest difference per this test. An engineering interpretation of this result is that the "W" muffler not only reduced the emissions consistently, but significantly.

On the lower half of Table 22, the muffler pressure and temperature measurements are summarized. Comparing the "W" to the stock differential pressures, it appears that the drop across the "W" unit was about the same or slightly less than the stock unit. A standard muffler was used for these tests in which one inlet was blanked off. Loss in heat as measured at the difference in muffler inlet and outlet temperatures was essentially the same. It is interesting to note the increase of 27°F for the stock and 70°F for the "W" unit during the idle condition. This represents a typical hot idle in which the bus is operated for several minutes at a cruise (30 mph, 40 hp) and allowed to decelerate to engine idle similar to street operation. The mass of the catalytic muffler acts as a heat sink during the powered cruise and warms the exhaust during the colder inlet conditions experienced at idle. Air box pressures appeared to be unaffected by "W." For complete details of the Code "W" catalytic muffler initial screening tests, please see Tables 31 to 37 of Appendix B.

TABLE 21. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "W" VS STOCK MUFFLER

Vehicle: Bus 678 **Fuel: EM-3A-F (No. 1 Diesel)**
Dates Evaluated: June 14 and 18, 1968

Constant Speed (All open rack--maximum power output)

Vehicle Speed, mph	Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
	Stock	"W"	
20	16.0	13.3	2.7
25	13.3	10.3	3.0
30	13.3	9.0	4.3
35	11.0	7.7	3.3

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
	Stock	"W"	
Engine Start	4.3	7.0	(2.7)*
During Acceleration	7.7	6.3	1.4
After Upshift	9.7	9.7	0

---

*( ) indicates increase in smoke with catalytic muffler installed.

TABLE 22. SUMMARY OF EXHAUST EMISSIONS AND MUFFLER PRESSURE AND TEMPERATURE MEASUREMENTS

Vehicle: Bus 678 Fuel: EM-3A-F (No. 1 Diesel)

Average "As-Measured" Exhaust Emissions

Operating Conditions	Test Date	CO, ppm		CO_2, Percent		Acrolein, ppm		Aliphatic Aldehydes*, ppm		Formaldehyde		NO_x, ppm	
		Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"
20 mph 40 hp	6/14, 19/68 U_s Statistic	558	81 0	3.43	4.35 0	3.73	0.93 0	25.43	23.74 [illegible]	12.05	8.83 0	670	664 [illegible]
40 mph 40 hp	6/14, 19/68 U_s Statistic	191	50 0	2.79	3.36 0	2.45	0.16 0	23.42	18.53 0.5	10.74	4.62 0	546	496 0
Idle	6/14, 19/68 U_s Statistic	199	30 0	0.83	0.93 0.5	3.03	0.13 0	24.20	13.66 0	10.38	3.88 0	228	208 0
30 mph 40 hp	6/14, 19/68 U_s Statistic	215	40 0	2	2.51 0	2.77	0.44 0	23.66	18.28 0.5	10.11	8.83 0.5	578	540 0

Average Muffler Pressure and Temperature Measurements

Operating Conditions	Test Date	Muffler Pressure, in. Hg						Muffler Temperature, °F						Air Box Pressure, in. Hg	
		Inlet		Outlet		Differential		Inlet		Outlet		Differential			
		Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"
20 mph - 40 hp	6/17, 18/68	0.05	0.26	0.29	0.08	0.24	0.18	504	541	342	395	161	154	1.00	0.96
40 mph - 40 hp	6/17, 18/68	0.30	0.80	0.75	0.43	0.45	0.36	515	539	412	427	101	111	4.90	4.60
Idle	6/17, 18/68	0.05	0.10	0.10	0.05	0.05	0.05	281	304	307	374	(27)	(70)	0.85	0.63
30 mph - 40 hp	6/17, 18/68	0.23	0.47	0.50	0.13	0.27	0.33	485	499	361	360	125	139	2.47	2.30

---

*Total as ppm formaldehyde.

3. Summary of Initial Screening Tests

Both "Z" units appear to lack promise for reduction of odor, smoke, and other diesel emissions based on the inspections made after a month of routine operation. "Z"-1, with the straight-through cartridges, appeared to have more mechanical design difficulties. These deficiencies, however, were adjudged minor in nature and could be corrected by redesign. It is likely that had "Z"-1 remained intact, the performance would not have been greatly different from "Z"-2, since the same catalyst coatings were used in both.

Code "W," handling half of the Detroit Diesel 6V-71 engine exhaust, was able to significantly and consistently reduce the perceived odor in four out of five conditions. Visible smoke was also lessened by attachment of this exhaust device. A significant reduction in CO and acrolein to about 25 percent of their usual concentration was found. Lesser, but significant reductions in aldehydes and formaldehyde were also recorded. As a result, the "W" device appears to be the best catalytic device available for reduction of diesel emissions and fleet test.

B. Additional Screening Tests

Concurrent with the operation of three city buses for 6 months equipped with a Code "W" muffler, additional screening tests of other candidate devices were conducted.

1. Description of Devices Evaluated

During the Part II project, an experimental honeycomb configuration (Code "Y") in the form of two small reactors was tried and found to be somewhat successful in reducing odor and certain other emissions. This test was made after field operation was curtailed due to excessive noise after 17 days (1979 miles) (Ref. 3). The revised version, Code "V," is shown in Figure 29 and is shown installed on city bus number 683 in Figures 30 and 31. Muffler code "U," supplied by the manufacturer of Code "V," is shown in Figure 32 and is of one-piece construction. Both devices depended on the use of a precious metal catalyst.

A third unit, Code "T," is shown in Figure 33 before and after an 8-week, 5,420-mile test in Bus 681. Apparently, the strength of the substrate and its mounting within the muffler was insufficient to withstand normal street operation.

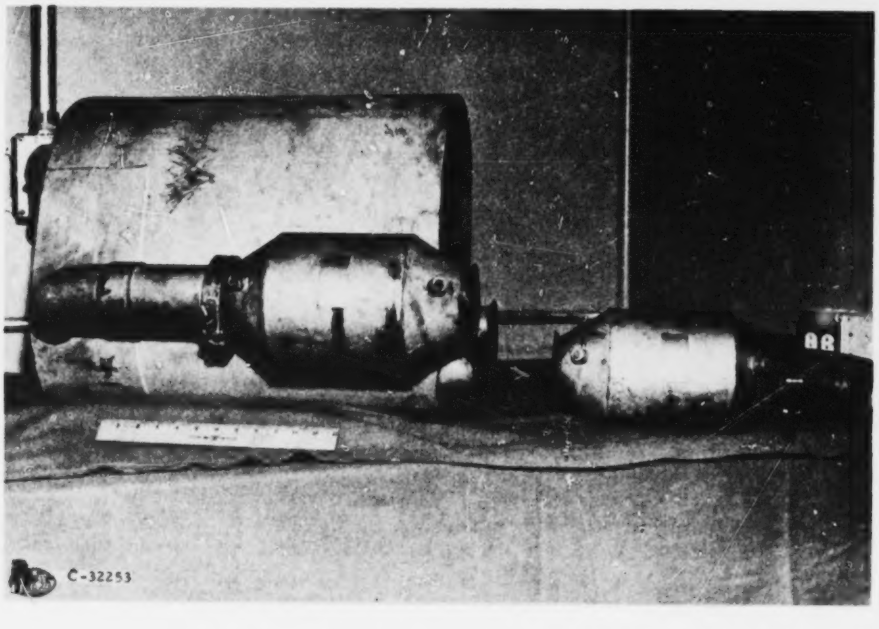


FIGURE 29. CATALYTIC MUFFLER CODE "V"

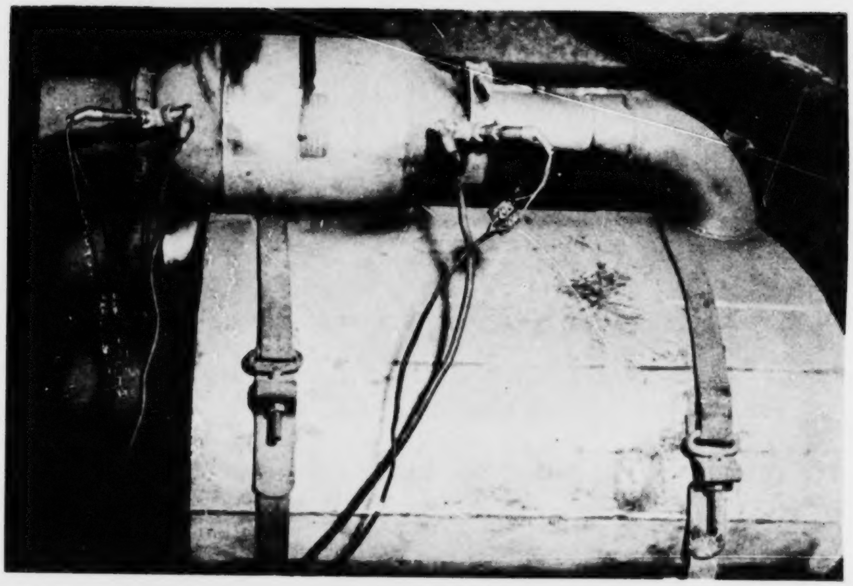


FIGURE 30. INSTALLATION OF CODE "V" CATALYTIC MUFFLER UNDER GM MODEL TDH 4519 COACH

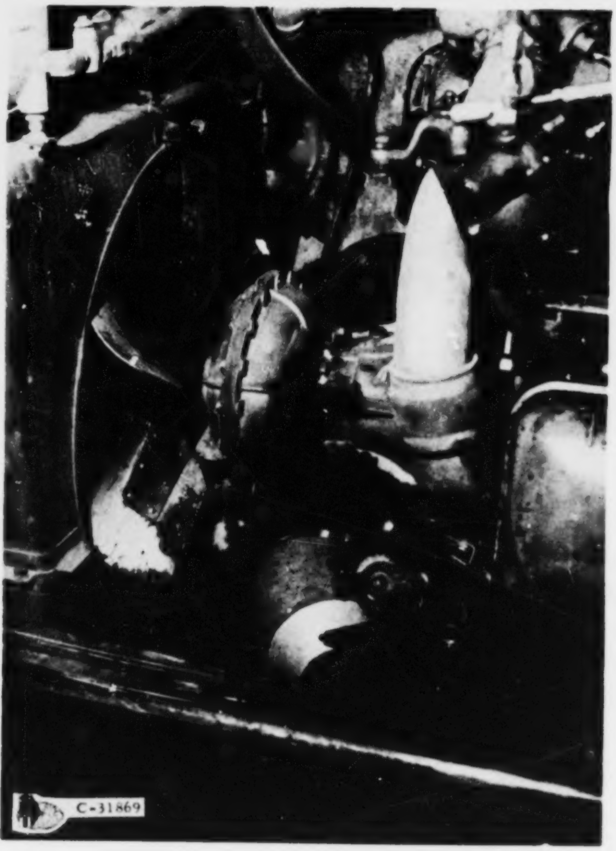


FIGURE 31. INSTALLATION OF CODE "V" CATALYTIC REACTOR SERVING REAR BANK OF ENGINE

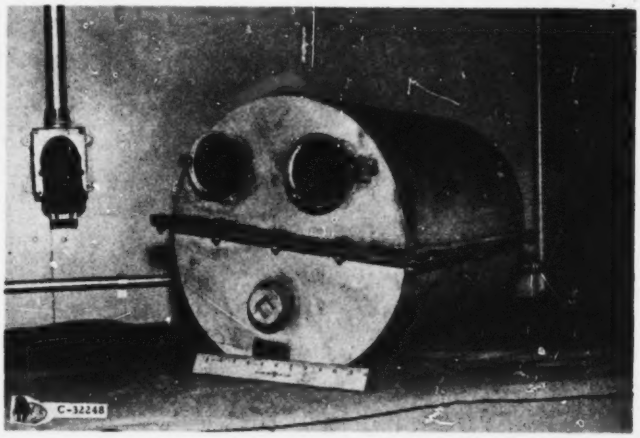
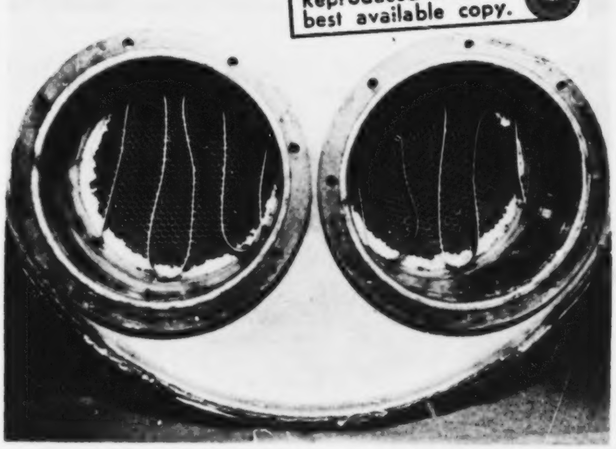


FIGURE 32. EXPERIMENTAL CATALYTIC MUFFLER CODE "U"

Reproduced from best available copy.



Before Test 0 Miles 0 Weeks
After Test 5420 Miles 8 Weeks

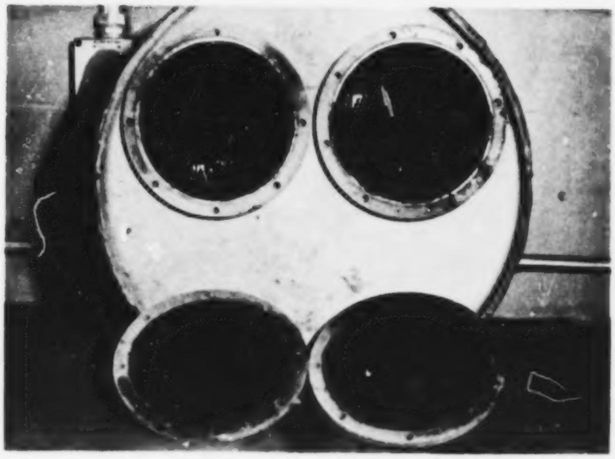


FIGURE 33. CODE "T" CATALYTIC MUFFLER

2. Results of Additional Screening Tests

Performance tests including odor, smoke, exhaust emissions, and muffler pressure and temperature data were obtained after approximately 30 days of routine operation on Bus 683 for mufflers "V" and "U." This San Antonio Transit vehicle was powered by a Detroit Diesel 6V-71 E two-valve engine with 60S injectors. The mileage accumulated on the Code "V" unit was 3478 miles and on Code "U" was 3784 miles.

a. Code "V" Screening Test Results

The results of the evaluation of Code "V" are summarized in Tables 23 (odor), 24 (smoke), and 25 (exhaust emissions). The Code "V" device appeared to reduce the "D" ratings and some of the qualities during the 20-, 30-, and 40-mph cruise conditions. Little or no benefit was noted during the idle or idle-acceleration and the deceleration ratings seemed slightly higher. These cruise differences for the most part appeared to be statistically different and, during the 30- and 40-mph runs, seemed consistent for the "D," "B," and "O" ratings. The bar charts in Figure 34 illustrate the total effect of the Code "V" catalytic muffler on the perceived exhaust odor.

Code "V," per Table 24, did not have a beneficial effect on the visible smoke during transient or cruise conditions. Table 25 lists the exhaust emissions of Code "V" relative to a stock

TABLE 23. COMPARISON OF ODOR PANEL RESPONSES FOR CATALYTIC MUFFLER CODE "V" AND STOCK MUFFLER

Vehicle: Bus 683
Date: January 23 and 24, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Muffler	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Stock	6.1	1.8	1.6	1.1	1.2
	"V"	5.5	1.8	1.2	1.1	1.2
	Net Change	-0.6	0	-0.4	0	0
	U_s Statistic	*	*	2	*	*
30 mph at 40 hp	Stock	5.9	1.9	1.6	1.0	1.0
	"V"	5.2	1.6	1.1	0.9	1.2
	Net Change	-0.7	-0.3	-0.5	-0.1	+0.2
	U_s Statistic	1.0	1.0	1.0	*	*
40 mph at 40 hp	Stock	6.1	1.9	1.6	1.0	1.1
	"V"	5.3	1.6	1.2	1.0	1.0
	Net Change	-0.8	-0.3	-0.4	0	-0.1
	U_s Statistic	0	1.5	1.0	*	*
Idle	Stock	5.8	1.9	1.6	1.2	1.0
	"V"	5.8	1.6	1.2	1.1	1.2
	Net Change	0	-0.3	-0.4	-0.1	+0.2
	U_s Statistic	*	0	0	*	*
Idle-Acceleration	Stock	6.2	1.9	1.8	1.1	1.1
	"V"	6.2	2.0	1.7	1.2	1.3
	Net Change	0	+0.1	-0.1	+0.1	+0.2
	U_s Statistic	*	*	*	*	*
Deceleration	Stock	5.5	1.7	1.5	1.1	0.9
	"V"	6.3	2.2	1.9	1.1	1.2
	Net Change	+0.8	+0.5	+0.4	0	+0.3
	U_s Statistic	0.5	0	0	*	0

---

*No statistical difference.

TABLE 24. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "V" AND STOCK MUFFLER

Vehicle: Bus 683 **Fuel: EM-70-F (No. 1 Diesel)**
Dates Evaluated: January 23, and 24, 1969

Constant Speed (All open rack--maximum power output)

Vehicle Speed, mph	Average PHS Smoke Readings, Percent Opacity		Smoke Reduction, Percent Opacity
	Stock	"V"	
20	11.7	13.7	(2.7)*
25	8.3	10.0	(2.3)
30	6.7	7.7	(1.0)
35	6.5	7.0	(0.5)

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Average PHS Smoke Readings, Percent Opacity		Smoke Reduction, Percent Opacity
	Stock	"U"	
Engine Start	6.7	7.3	(0.6)
During Acceleration	4.3	8.5	(4.2)
After Upshift	4.5	8.7	(4.2)

---

*( ) indicates increase in smoke with catalytic muffler installed.

TABLE 25. EXHAUST EMISSIONS SUMMARY, CATALYTIC MUFFLER CODE "V" AND STOCK MUFFLER

Vehicle: Bus 683 Date: January 23 and 24, 1969

Average As-Measured Exhaust Emissions

Operating Conditions	Muffler	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
20 mph 40 hp	Stock	1309	3.9	1997	5	31	18	840	879
	"V"	229	4.2	447	1	10	2	880	865
	U_s Statistic	0	1	0	0	0	0	*	*
30 mph 40 hp	Stock	279	3.3	2051	3	30	11	949	900
	"V"	148	3.5	690	1	12	2	952	920
	U_s Statistic	0	1	0	0	0	0	*	*
40 mph 40 hp	Stock	242	3.5	1777	2	19	6	872	819
	"V"	156	3.5	679	1	12	2	819	825
	U_s Statistic	0	*	0	0	0	0	*	*
Idle	Stock	255	0.6	611	3	27	8	297	328
	"V"	240	0.8	354	1	15	4	320	365
	U_s Statistic	1.5	0	0	0	0	0.5	*	1

Average Muffler Pressure and Temperature Measurements

Operating Conditions	Muffler	Muffler Pressure, in. Hg.			Muffler Temperature, °F			Air Box Pressure, in. Hg.
		Inlet	Outlet	Differential	Inlet	Outlet	Differential	
20 mph 40 hp	Stock	0.9	0.5	0.4	620	510	113	1.4
	"V" Reactor (Front Bank)	1.6	1.2	0.4	605	545	60	1.9
	Overall "V" System			1.1				
30 mph 40 hp	Stock	1.5	0.8	0.7	595	500	95	2.8
	"V" Reactor (Front Bank)	2.4	1.8	0.6	555	506	49	3.6
	Overall "V" System			1.6				
40 mph 40 hp	Stock	2.5	1.4	1.1	618	550	68	5.5
	"V" Reactor (Front Bank)	4.0	3.0	1.0	592	550	41	6.5
	Overall "V" System			2.6				
Idle	Stock	0.2	0.1	0.1	298	345	(48)	0.7
	"V" Reactor (Front Bank)	0.4	0.3	0.2	303	284	18	0.8
	Overall "V" System							

---

*U_s statistic greater than 2, no statistical difference apparent.

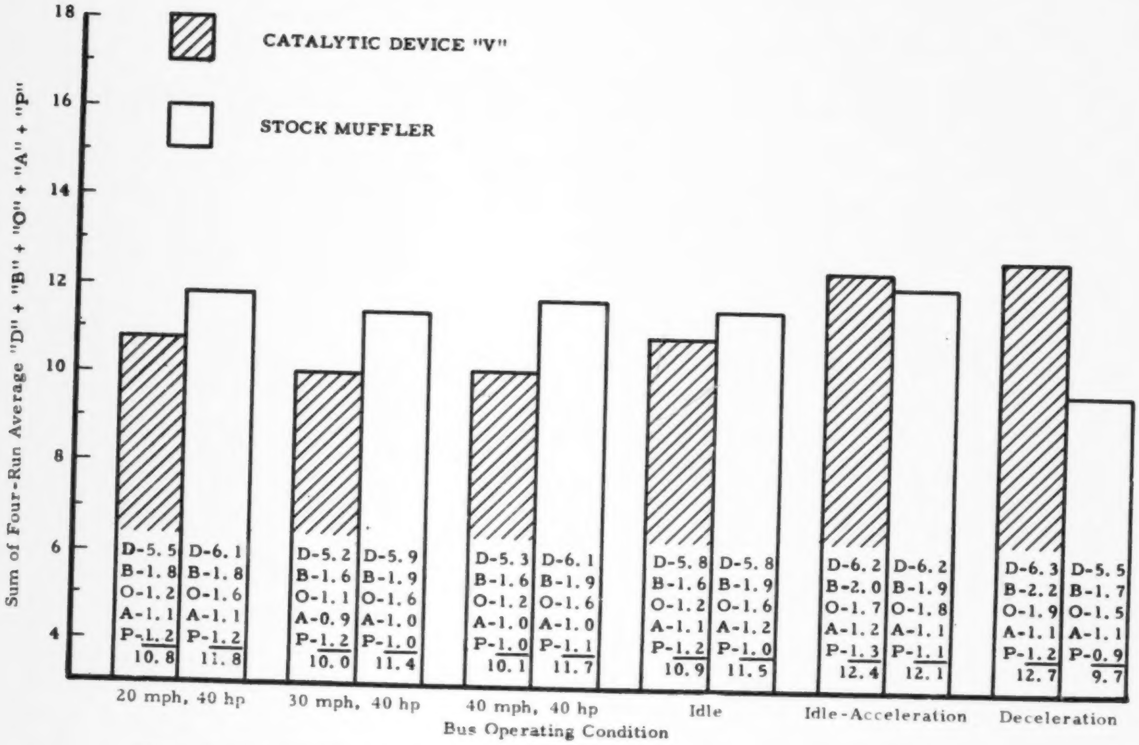


FIGURE 34. OVERALL COMPARISON OF DIESEL ODOR EVALUATION WITH AND WITHOUT CODE "V" CATALYTIC MUFFLER INSTALLED

muffler for the four cruises studied. CO was reduced as were hydrocarbons and partially oxygenated materials such as acrolein, aldehydes, and formaldehyde. Practically all data with and without catalyst were statistically different though the magnitude of certain differences in CO cannot be judged gross. HC was significantly reduced as were formaldehyde and acrolein. Muffler pressures and temperatures are also listed in Table 25 for comparison. The inlet pressure was higher for the Code "V" front bank reactor, but the pressure drop across the reactor was the same as the stock muffler. The overall Code "V" system pressure drop, reactor plus muffler, was substantially greater than the conventional muffler.

b. Code "U" Screening Test Results

The Code "U" device performance is likewise summarized in Tables 26 (odor), 27 (smoke), 28 (exhaust emissions), and Figure 35. This experimental device was mostly effective during the idle and two transient conditions and most changes, though slight, were identified as statistically different. The overall odor performance is shown in Figure 35. The noticeable improvement during idle and transient conditions is puzzling as these generally are the most difficult conditions to control. The lack of substantial and continual heat during the "low" temperature idle and fast acting transients have made these conditions, realistic of bus operation, an important test of a device's performance.

Smoke tendency, per Table 27, was not particularly affected during cruise at max power. A review of Table 28 reveals reductions in HC, acrolein, aldehydes, and formaldehyde that were statistically different. Muffler temperatures and pressures are listed for both stock and Code "U" mufflers. Air box pressures appeared normal. Please see Tables 38 to 47 in Appendix B for complete details of the evaluation of Code "V" and "U" devices.

In summary, the two catalytic devices coded "V" and "U" were subjected to smoke, odor, and exhaust emissions measurements after 30 days of routine bus operation. Reduction in odor

TABLE 26. COMPARISON OF ODOR PANEL RESPONSES FOR CATALYTIC MUFFLER CODE "U" AND STOCK MUFFLER

Vehicle: Bus 683
Date: March 11 and 12, 1969
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Muffler	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Stock	5.7	1.9	1.4	1.2	1.0
	"U"	5.8	1.7	1.3	1.2	1.1
	Net Change	+0.1	-0.2	-0.1	0	+0.1
	U_s Statistic	*	*	*	*	*
30 mph at 40 hp	Stock	5.2	1.6	1.3	1.0	1.0
	"U"	5.4	1.5	1.2	1.1	1.1
	Net Change	+0.2	-0.1	-0.1	+0.1	+0.1
	U_s Statistic	*	*	*	*	*
40 mph at 40 hp	Stock	5.5	1.7	1.4	1.2	1.0
	"U"	5.3	1.5	1.3	1.1	1.1
	Net Change	-0.2	-0.2	-0.1	-0.1	+0.1
	U_s Statistic	*	*	*	*	*
Idle	Stock	5.7	1.9	1.6	1.2	1.1
	"U"	5.1	1.4	1.1	1.1	1.0
	Net Change	-0.6	-0.5	-0.5	-0.1	-0.1
	U_s Statistic	0	0	0	0	0
Idle-Acceleration	Stock	6.3	2.1	1.9	1.3	1.2
	"U"	5.8	1.9	1.4	1.1	1.1
	Net Change	-0.5	-0.2	-0.5	-0.2	-0.1
	U_s Statistic	*	1.5	0.5	*	*
Deceleration	Stock	5.6	1.8	1.4	1.2	0.9
	"U"	4.7	1.3	1.1	1.1	0.9
	Net Change	-0.9	-0.5	-0.3	-0.1	0
	U_s Statistic	0.5	0.5	1.5	*	*

---

*No statistical difference.

TABLE 27. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "U" AND STOCK MUFFLER

Vehicle: Bus 683
Dates Evaluated: March 11 and 12, 1969
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed (All open rack--maximum power output)

Vehicle Speed, mph	Average PHS Smoke Readings, Percent Opacity		Smoke Reduction, Percent Opacity
	Stock	"U"	
20	13.0	14.3	(1.3)*
25	10.0	9.3	0.7
30	8.0	6.3	1.7
35	7.0	5.3	1.7

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Average PHS Smoke Readings, Percent Opacity		Smoke Reduction, Percent Opacity
	Stock	"U"	
Engine Start	10.0	7.0	3.0
During Acceleration	6.7	11.0	(4.3)
After Upshift	7.7	6.0	1.7

---

*( ) indicates increase in smoke with catalytic muffler installed.

TABLE 28. EXHAUST EMISSION SUMMARY, CATALYTIC MUFFLER CODE "U" AND STOCK MUFFLER

Vehicle: Bus 683

Date: March 11 and 12, 1969

Average As-Measured Exhaust Emissions

Operating Conditions	Muffler	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
20 mph 40 hp	Stock	1291	4.7	1757	4	34	14	765	765
	"U"	864	5.0	958	3	20	10	843	348
	U_s Statistic	*	0.5	0	1	0	0	*	0
30 mph 40 hp	Stock	234	3.6	1647	3	22	10	912	738
	"U"	184	3.7	963	1	17	5	797	825
	U_s Statistic	*	*	0	0	2	0	0	0
40 mph 40 hp	Stock	178	3.3	1460	2	25	7	805	689
	"U"	144	3.4	829	1	21	4	730	728
	U_s Statistic	*	*	0	0	*	1	0.5	*
Idle	Stock	266	0.8	470	3	25	10	280	258
	"U"	89	1.1	162	1	16	5	268	335
	U_s Statistic	0	0	0	0	0	0	*	0.5

Average Muffler Pressure and Temperature Measurements

Operating Conditions	Muffler	Muffler Pressure, in H_2O			Muffler Temperature, °F			Air Box Pressure, in. Hg.
		Inlet	Outlet	Differential	Inlet	Outlet	Differential	
20 mph 40 hp	Stock	14.1	9.1	5.0	528	465	63	1.8
	"U"	9.3	4.1	5.1		405		1.7
30 mph 40 hp	Stock	26.9	17.6	8.5	424	445	(21)	3.6
	"U"	16.3	8.6	8.0		423		3.2
40 mph 40 hp	Stock	49.0	33.5	15.3	431	455	(24)	6.6
	"U"	28.0	14.8	12.5		418		5.7
Idle	Stock	2.5	2.0	0.8	190	290	(100)	0.9
	"U"	2.6	1.1	1.5		393		0.9

---

* U_s statistic greater than 2, no statistical difference apparent.

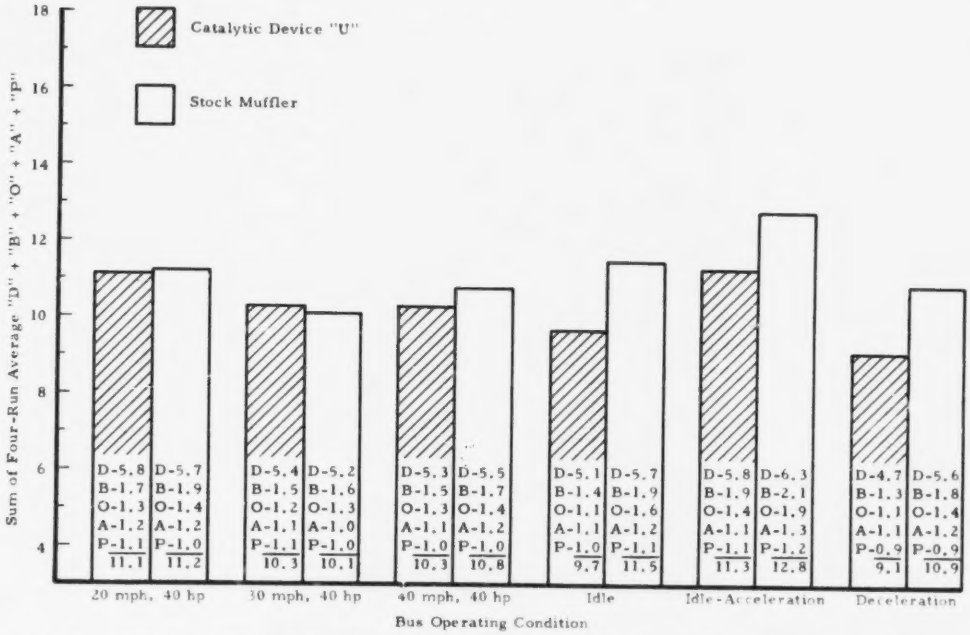


FIGURE 35. OVERALL COMPARISON OF DIESEL ODOR EVALUATION WITH AND WITHOUT CODE "U" CATALYTIC MUFFLER INSTALLED

was found during cruise conditions with device "V" and transient conditions with device "U." Odor reduction, though statistically valid, was not adjudged substantial though both devices, particularly Code "V," were effective in reducing hydrocarbons, CO, aldehydes, formaldehyde, and acrolein. Visible smoke seemed little affected by the catalytic devices, and muffler pressures, though higher than the stock muffler, appeared satisfactory.

C. Fleet Test of Code "W" Muffler

The selection of the catalytic device, known as Code "W," for the three-bus 6-month test was made on the basis that it appeared to be the most effective muffler design and catalyst substrate system of those evaluated and also appeared to have the greatest potential in this application. It should be pointed out, however, that this unit was not specifically designed for bus application, and, as a result, the installation and the muffler configuration employed were different from that which probably would be used. The Code "W" muffler could not be mounted in a horizontal position, similar to the under-the-coach type muffler normally used. Also, the Code "W" unit was not large enough to handle the entire gas flow from the engine. The third drawback was that the sound level of the exhaust from this unit was higher than acceptable for municipal bus service.

1. Preparations

A group of three similar buses, No. 677, 679, and 681, was selected from the San Antonio Transit System fleet. These GM Truck and Coach Model TDH 4519 units were powered by Detroit Diesel 6V-71 E engines, two-valve with 60S injectors. No maintenance or preparations to the engine or vehicle were made as part of starting this 6-month duration test, and the usual No. 1 kerosene type diesel fuel was used.

Installation of the catalytic units in the engine compartment such that the exhaust from the rear bank of three cylinders was directed into the bottom of the unit and out of the top resulted in maximum heat input and retention. The exhaust was then routed into the stock muffler, located under the coach in front of the engine where it mixed with the exhaust from the front bank and then exited the vehicle through the normal tailpipe. The Code "W" unit was slightly oversize for three cylinders and this arrangement resulted in acceptable pressure drop, exhaust system backpressure, and the usual low noise level from the stock muffler.

The installation of this unit is shown in Figure 36. For laboratory test, the exhaust from the catalytic muffler is ducted through the flexible pipe shown directly to the laboratory exhaust sampling

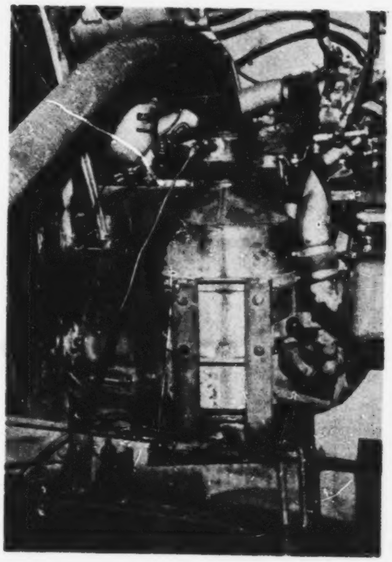


FIGURE 36. CODE "W" CATALYTIC MUFFLER INSTALLED IN CITY BUS

odor dilution system. The back-to-back evaluation includes handling the exhaust from the same bank of the engine through a stock muffler. The Code "W" unit is designed so the exhaust gases enter from the bottom and pass through an annular ring of catalyst employing a precious metal and then through the outer shell and up through the top of the unit. A filler port for checking the catalyst level and replenishment is provided on top of the unit.

The evaluations were conducted at the beginning, midway, and at the end of 6 months of operation according to the schedule shown in Tables 29 through 31 for Buses 677, 679, and 681, respectively. Each evaluation included back-to-back measurement of odor, smoke, and other emissions as well as pertinent muffler pressures and temperatures. Mileage accumulation was with a commercial No. 1 kerosene type diesel fuel, coded EM-73-F. During inspections, the Emissions Laboratory special supply of No. 1 kerosene fuel coded EM-70-F, a fuel very similar to that used during mileage accumulation, was employed. Mileage accumulation was fairly similar in that all three units operated on the same route and were placed in high rate accumulation service. In addition to emissions performance, records were maintained of fuel and oil consumption and engine maintenance.

2. Results

To handle the extensive data generated by this fleet test, overall summaries are presented for each bus covering the three inspection periods with and without catalytic muffler. The three units, Buses 677, 679, and 681, are summarized in the same way. First, the overall odor summary; next, the smoke results; then, the exhaust chemistry summary; and, finally, the pressure and temperature summary.

For purposes of discussion, all three vehicles will be considered by emission category. The odor data, Tables 32, 36, and 40 for Buses 677, 679, and 681, show that most of the time the odor additive was effective in reducing the odor ratings slightly. The magnitude of the changes, however, is moderate to slight such that, when subjected to the nonparametric U_s test for statistical difference, less than half of the instances may be considered a real change (i.e., not within the variability of the experimental data).

TABLE 29. VEHICLE 677 SCHEDULE OF CATALYTIC MUFFLER CODE "W"-1 EVALUATIONS

Date	Test Months	Total Mileage	Test Miles	Description of Test Conducted
9/18/68	0	279,888	0	Installed Code "W"-1 muffler
9/19/68	0	279,888	0	Evaluated emissions, odor, and smoke--Code "W"-1
				Installed stock muffler
9/29/68	0	279,888	0	Evaluated emissions, odor, and smoke--stock muffler
				Reinstalled Code "W"-1 muffler
12/11/68	3	284,274	4,386	Evaluated emissions, odor, and smoke--Code "W"-1
				Installed stock muffler
12/12/68	3	284,274	4,386	Evaluated emissions, odor, and smoke--stock muffler
				Reinstalled Code "W"-1 muffler
3/18/69	6	290,088	10,200	Evaluated emissions, odor, and smoke--Code "W"-1
				Installed stock muffler
3/19/69	6	290,088	10,200	Evaluated emissions, odor, and smoke--stock muffler
				Regenerated Code "W"-1 muffler
3/20/69	6	290,088	10,200	Evaluated emissions, odor, and smoke--Code "W"-1
				Reinstalled stock muffler

TABLE 30. VEHICLE 679 SCHEDULE OF CATALYTIC MUFFLER CODE "W"-2 EVALUATIONS

Date	Test Months	Total Mileage	Test Miles	Description of Test Conducted
9/27/68	0	261, 213	0	Installed Code "W"-2 muffler
9/30/68	0	261, 213	0	Evaluated emissions, odor, and smoke--Code "W"-2 muffler
				Installed stock muffler
10/1/68	0	261, 213	0	Evaluated emissions, odor, and smoke--stock muffler
				Reinstalled Code "W"-2 muffler
12/17/68	3	265, 217	4, 004	Evaluated emissions, odor, and smoke--Code "W"-2 muffler
				Installed stock muffler
12/18/68	3	265,217	4,004	Evaluated emissions, odor, and smoke--stock muffler
				Reinstalled Code "W"-2 muffler
3/26/69	6	272, 318	11, 105	Evaluated emissions, odor, and smoke--Code "W"-2 muffler
				Installed stock muffler
3/27/69	6	272, 318	11, 105	Evaluated emissions, odor, and smoke--stock muffler
				Regenerated Code "W"-2 muffler
3/28/69	6	272, 318	11, 105	Evaluated emissions, odor, and smoke--Code "W"-2 muffler

TABLE 31. VEHICLE 681 SCHEDULE OF CATALYTIC MUFFLER CODE "W"-3 EVALUATIONS

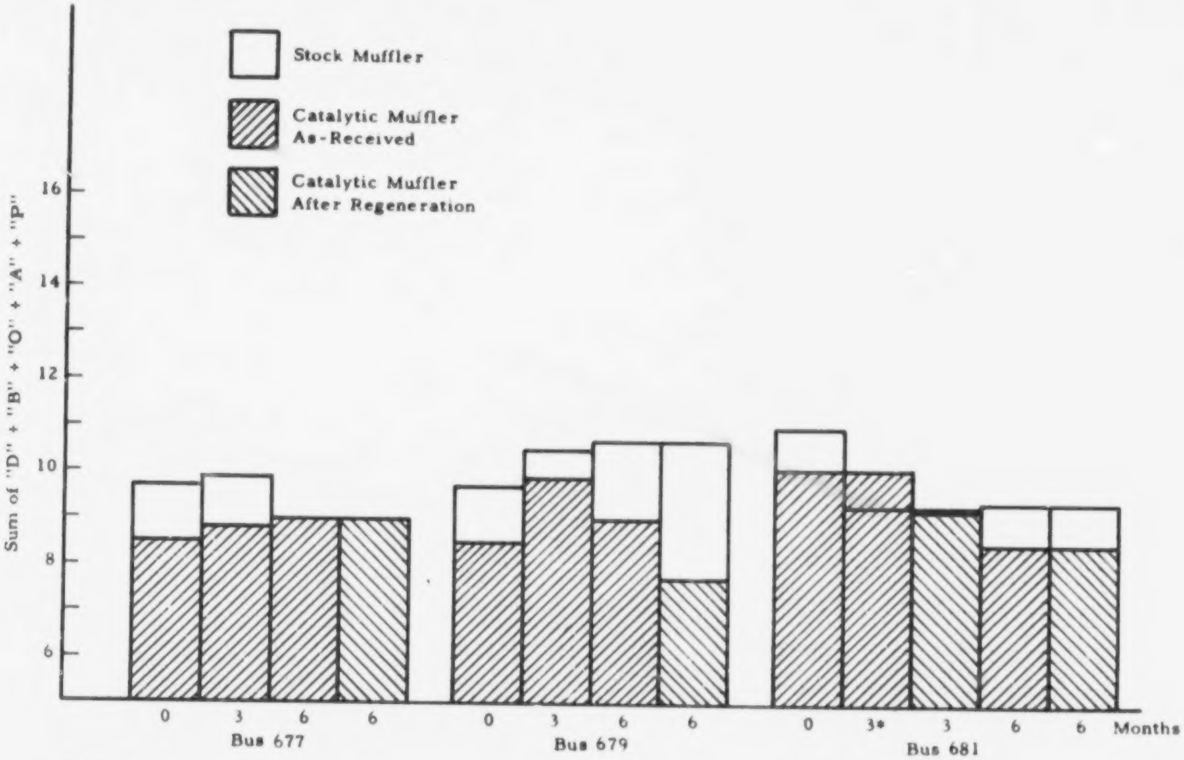
Date	Test Months	Mileage	Test Miles	Description of Test Conducted
10/8/68	0	283, 872	0	Installed Code "W"-3 muffler
10/9/68	0	283, 872	0	Evaluated emissions, odor, and smoke--Code "W"-3 muffler
				Installed stock muffler
10/10/68	0	283, 872	0	Evaluated emissions, odor, and smoke--stock muffler
				Reinstalled Code "W"-3 muffler
1/6/69	3	288, 581	4, 709	Evaluated emissions, odor, and smoke--Code "W"-3 muffler
				Installed stock muffler
1/7/69	3	288, 581	4, 709	Evaluated emissions, odor, and smoke--stock muffler
				Reinstalled "W"-3 muffler
1/15/69		289, 192	5, 250	Regenerated "W"-3 muffler
4/1/69	6	294, 622	10, 750	Evaluated emissions, odor, and smoke--stock muffler
				Installed stock muffler
4/2/69	6	294, 622	10, 750	Evaluated emissions, odor, and smoke--stock muffler
				Regenerated Code "W"-3 muffler
4/3/69	6	294, 622	10, 750	Evaluated emissions, odor, and smoke--Code "W"-3 muffler

Considering all the odor results, it appears that the Code "W" unit reduced the odor best on Bus 679 followed by Bus 681 and then 677, based mostly on "D" ratings. In almost all instances, regeneration seemed to improve performance though did not seem to be particularly helpful on Bus 677. The idle condition seemed to be affected the least by the Code "W" unit. The decel condition, however, usually was reduced in its odor and even the pungent "P" level was affected.

The general conclusions are illustrated by Figures 37 through 42 which are bar graphs of the sum of the "D" + "B" + "O" + "A" + "P" for each of the six conditions studied. This sum is superimposed on the bar graph over that obtained with the stock muffler and shows how well the overall performance of the Code "W" units was with time for each of the three buses.

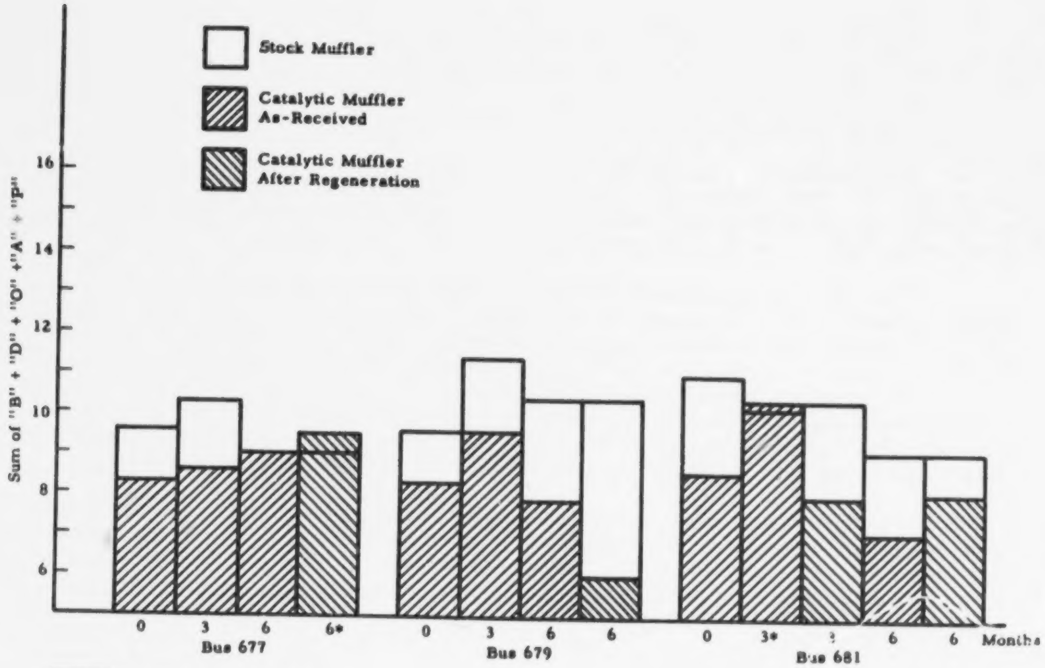
One of the three catalytic mufflers exhibited such marginal performance at the midtest (3 months) inspection that regeneration of the unit was deemed necessary. Because of the difficulty in fitting the current catalytic device configuration into the vehicle exhaust system, it was necessary to remove the muffler and install a special "spool piece" containing a burner for adding heat to the exhaust prior to its entry into the catalyst bed. In this way, the bed was "burned off" and the catalyst material surface renewed. Regeneration requires metering fuel and compressed air to the burner while the engine is operated at high idle for about 45 min. Whether the unit was adjudged to need regeneration or not, each unit was regenerated at the end of 6 months and an additional test performed.

Although no particular smoke reduction was expected by using the catalytic device, periodic smoke tests were made using the PHS full-flow, light-extinction meter. The results of these tests are summarized in Tables 33, 37, and 41 for Buses 677, 679, and 681. A review of this summary data shows the muffler to have little or no beneficial effect on visible smoke. In many instances, the smoke was slightly higher with the catalytic device than with the stock muffler. No effect on observed vehicle power output or engine performance was noted.



*Catalytic greater than stock.

FIGURE 37. PERFORMANCE OF CODE "W" CATALYTIC MUFFLERS ON EXHAUST ODOR
20 MPH - 40 HP CRUISE



*Catalytic greater than stock.

FIGURE 38. PERFORMANCE OF CODE "W" CATALYTIC MUFFLERS ON EXHAUST ODOR
30 MPH - 40 HP CRUISE

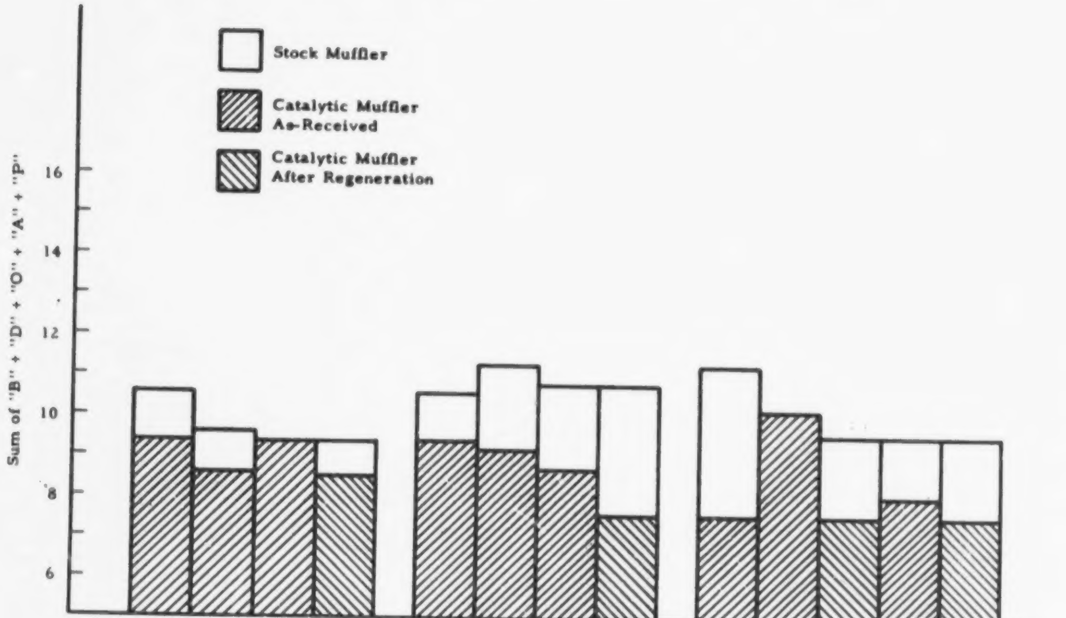
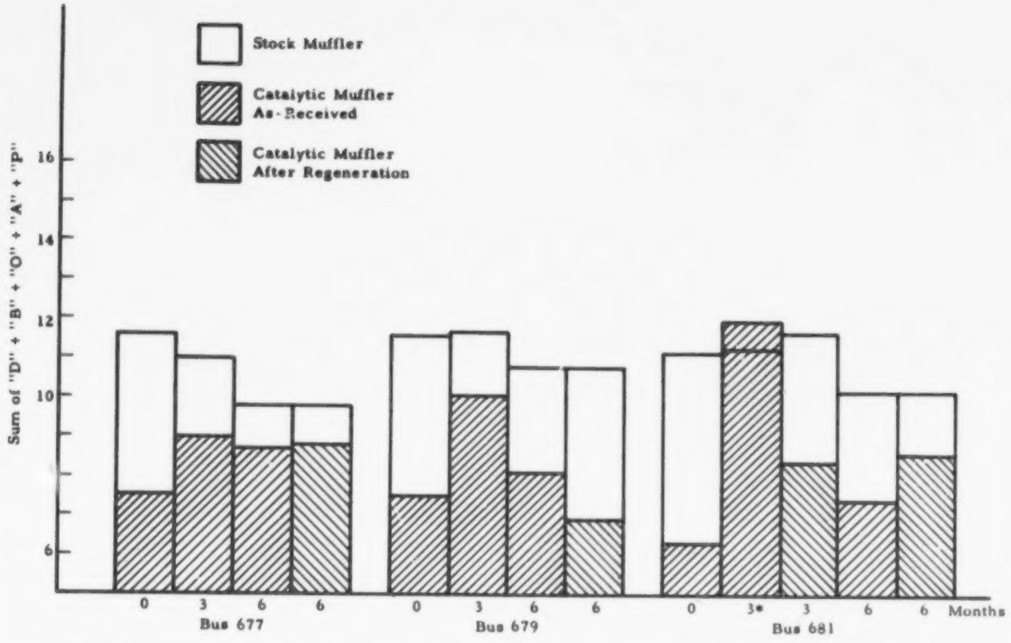


FIGURE 39. PERFORMANCE OF CODE "W" CATALYTIC MUFFLERS ON EXHAUST ODOR
40 MPH - 40 HP CRUISE



*Catalytic greater than stock.

FIGURE 40. PERFORMANCE OF CODE "W" CATALYTIC MUFFLERS ON EXHAUST ODOR IDLE

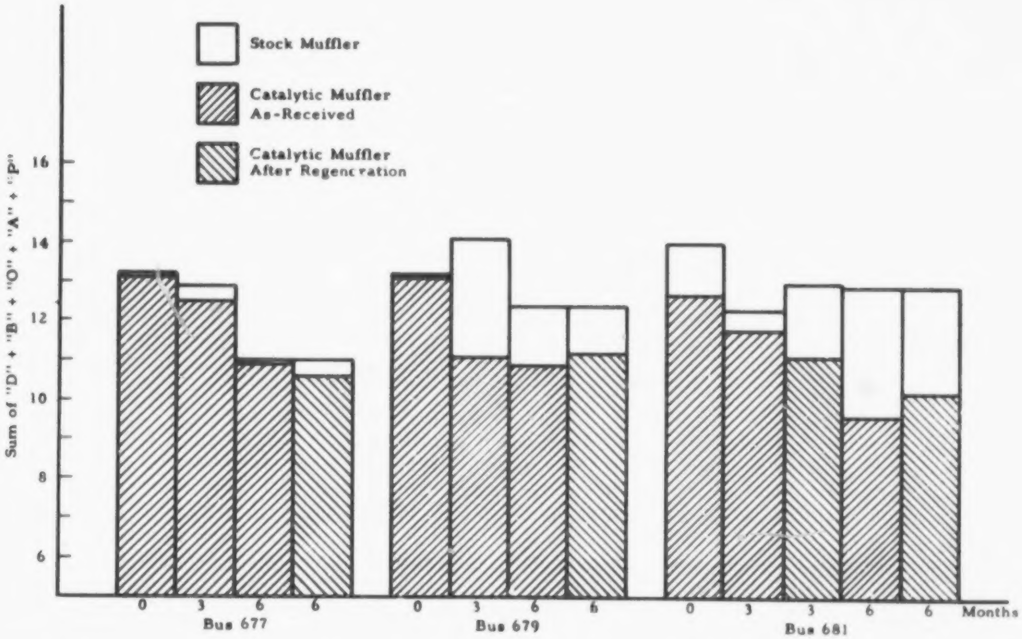


FIGURE 41. PERFORMANCE OF CODE "W" CATALYTIC MUFFLERS ON EXHAUST ODOR IDLE-ACCELERATION

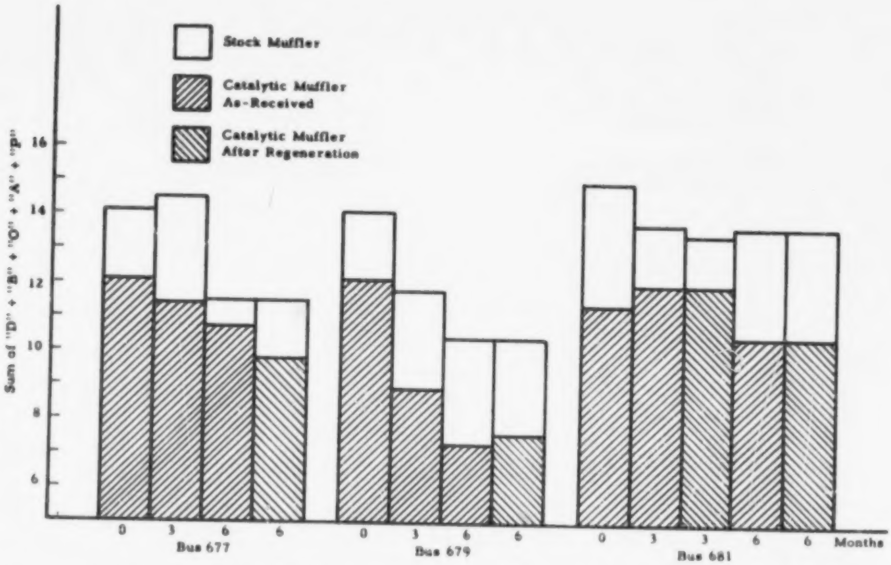


FIGURE 42. PERFORMANCE OF CODE "W" CATALYTIC MUFFLERS ON EXHAUST ODOR - DECELERATION

Listed on Tables 34, 38, and 42 are the exhaust emissions measured simultaneously with odor for Buses 677, 679, and 681, respectively. Each table is organized for the four conditions investigated at the beginning, halfway, and at the end of the test such that the stock may be compared with the catalytic results. The as-measured concentrations in the exhaust are listed for CO, CO_2, hydrocarbons, acrolein, aldehydes, formaldehyde, NO_x by Saltzman, NO, and NO_2. Considering the difference in values for the stock and the catalytic mufflers and the strength of the U test, which gave a large percentage of U statistics equal to 0, the catalytic muffler had a significant effect on emissions. Substantial reductions in total hydrocarbons and CO were noted under all conditions for all three buses. On a less consistent yet mostly encouraging basis, the partially oxygenated materials such as acrolein, total aldehydes, and formaldehyde likewise showed reductions, particularly acrolein and formaldehyde. NO, by nondispersive infrared, seemed mostly unaffected by the catalytic muffler. Occurrence of NO_2 seemed less with the catalytic muffler than with the stock muffler. Regeneration seemed to affect the exhaust emissions such as hydrocarbons. One exception was Bus 681 after 3 and 6 months of operation.

Tables 35, 39, and 43 summarize pressure and temperature measurements made with the catalytic and the stock muffler for each of the three vehicles. Considering the pressure drop across the device, it appears that the restriction due to the catalyst bed generally increased between the initial and interim inspections and then decreased or stayed the same between the interim and final. Regeneration seemed to be effective in reducing the pressure drop across the device, for all buses, under all conditions except idle.

Though the inlet temperatures were about the same for a specific condition, it seemed that the temperature differential (difference between the inlet and outlet temperatures) increased with mileage accumulation for most buses and most conditions, idle excluded. Regeneration, in many cases, had the effect of reducing the temperature differential from that measured prior to regeneration except in the case of Bus 681 in which the temperature increased after regeneration. Using the oversize catalytic muffler (somewhat larger than required to handle the airflow from the rear bank of the engine alone) resulted in air box pressures essentially identical to that with the stock muffler.

Included in Appendix B are listings of the data obtained during this fleet test. Tables 44 to 99 of Appendix B contain the odor summaries and supporting odor data for the three evaluations of each of the three vehicles. A smoke data sheet, chemistry emissions summary, and a muffler pressure and temperature summary are included with the odor test summary for each back-to-back evaluation.

TABLE 32. OVERALL SUMMARY OF ODOR EVALUATIONS CATALYTIC MUFFLER "W"-1 VS STOCK MUFFLER

Vehicle: Bus 677
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Inspection Period	Test Months	Test Miles	Test Date	Muffler Installed	"As-Received"						After Regeneration				
						"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph 40 hp	Initial	0	0	9/20/68	Stock	4.9	1.6	1.3	1.1	0.8						
				9/19/68	"W"-1	4.6	1.2	0.9	0.9	0.9						
					Net Change	-0.3	-0.4	-0.4	-0.2	+0.1						
					U_s Statistic	*	0	0	*	*						
	Interim	3	4,386	12/12/68	Stock	5.4	1.5	1.1	1.0	0.9						
				12/11/68	"W"-1	4.7	1.2	1.2	0.8	0.9						
					Net Change	-0.7	-0.3	+0.1	-0.2	0						
					U_s Statistic	0	1.5	*	*	*						
	Final	6	10,200	3/19/69	Stock	4.7	1.3	1.1	1.0	0.8	3/19/69	4.7	1.3	1.1	1.0	0.8
				3/18/69	"W"-1	4.7	1.4	1.1	1.0	0.9	3/20/69	4.6	1.3	1.1	1.0	0.8
					Net Change	0	+0.1	0	0	+0.1		-0.1	0	0	0	0
					U_s Statistic	*	*	*	*	*		*	*	*	*	*
30 mph 40 hp	Initial	0	0	9/20/68	Stock	5.1	1.4	1.3	1.1	0.7						
				9/19/68	"W"-1	4.5	1.2	0.9	0.8	0.9						
					Net Change	-0.6	-0.2	-0.4	-0.3	+0.2						
					U_s Statistic	0.5	*	1.5	1.5	2						
	Interim	3	4,386	12/12/68	Stock	5.3	1.7	1.3	1.0	1.0						
				12/11/68	"W"-1	4.5	1.1	1.1	0.9	1.0						
					Net Change	-0.8	-0.6	-0.2	-0.1	0						
					U_s Statistic	0	0.5	1	*	*						
	Final	6	10,200	3/19/69	Stock	4.6	1.4	1.1	1.1	0.8	3/19/69	4.6	1.4	1.1	1.1	0.8
				3/18/69	"W"-1	4.6	1.5	1.1	1.1	0.8	3/20/69	5.0	1.4	1.1	1.0	1.0
					Net Change	0	+0.1	0	0	0		+0.4	0	0	-0.1	+0.2
					U_s Statistic	*	*	*	*	*		0	*	*	*	1
40 mph 40 hp	Initial	0	0	9/20/68	Stock	5.4	1.8	1.5	1.1	0.8						
				9/19/68	"W"-1	5.0	1.4	1.1	1.0	0.9						
					Net Change	-0.4	-0.4	-0.4	-0.1	+0.1						
					U_s Statistic	1.0	0	1.5	*	*						
	Interim	3	4,386	12/12/68	Stock	5.1	1.5	1.2	0.9	0.9						
				12/11/68	"W"-1	4.5	1.2	1.1	0.9	0.9						
					Net Change	-0.6	-0.3	-0.1	0	0						
					U_s Statistic	1	0.5	*	*	*						
	Final	6	10,200	3/19/69	Stock	4.9	1.5	1.1	1.0	0.8	3/19/69	4.9	1.5	1.1	1.0	0.9
				3/18/69	"W"-1	4.8	1.5	1.1	1.1	0.9	3/20/69	4.4	1.3	1.0	1.0	0.8
					Net Change	-0.1	0	0	+0.1	+0.1		-0.5	-0.2	-0.1	0	-0.1
					U_s Statistic	*	*	*	*	*		0	*	*	*	*
Idle	Initial	0	0	9/20/68	Stock	6.0	1.9	1.6	1.1	1.0						
				9/19/68	"W"-1	3.9	1.2	0.9	0.8	0.7						
					Net Change	-2.1	-0.7	-0.7	-0.3	-0.3						
					U_s Statistic	0	0	0	2.0	0.5						
	Interim	3	4,386	12/12/68	Stock	5.7	1.7	1.5	1.1	1.0						
				12/11/68	"W"-1	4.9	1.2	1.0	0.9	1.0						
					Net Change	-0.8	-0.5	-0.5	-0.2	0						
					U_s Statistic	*	2	1.0	1	*						
	Final	6	10,200	3/19/69	Stock	5.0	1.6	1.2	1.1	0.9	3/19/69	5.0	1.6	1.2	1.1	0.9
				3/18/69	"W"-1	4.5	1.3	1.1	1.0	0.8	3/20/69	4.5	1.4	1.1	1.0	0.8
					Net Change	-0.5	-0.3	-0.1	-0.1	-0.1		-0.5	-0.2	-0.1	-0.1	-0.1
					U_s Statistic	2	2.0	*	*	*		2	*	*	*	*
Idle-Acceleration	Initial	0	0	9/20/68	Stock	6.7	2.1	1.8	1.2	1.4						
				9/19/68	"W"-1	6.7	2.1	1.8	1.2	1.3						
					Net Change	0	0	0	0	0.1						
					U_s Statistic	*	*	*	*	*						
	Interim	3	4,386	12/12/68	Stock	6.6	2.0	1.9	1.3	1.1						
				12/11/68	"W"-1	6.4	2.0	1.8	1.2	1.1						
					Net Change	-0.2	0	-0.1	-0.1	0						
					U_s Statistic	*	*	*	*	*						
	Final	6	10,200	3/19/69	Stock	5.6	1.8	1.4	1.2	1.0	3/19/69	5.6	1.8	1.4	1.2	1.0
				3/18/69	"W"-1	5.4	1.8	1.6	1.1	1.0	3/20/69	5.5	1.6	1.5	1.1	0.9
					Net Change	-0.2	0	+0.2	-0.1	0		-0.1	-0.2	+0.1	-0.1	-0.1
					U_s Statistic	*	*	*	*	*		*	*	*	*	*
Deceleration	Initial	0	0	9/20/68	Stock	7.1	2.2	1.9	1.3	1.6						
				9/19/68	"W"-1	6.2	1.9	1.6	1.2	1.2						
					Net Change	-0.9	-0.3	-0.3	-0.1	-0.4						
					U_s Statistic	1.5	0.5	2	*	1.5						
	Interim	3	4,386	12/12/68	Stock	7.5	2.2	2.0	1.5	1.3						
				12/11/68	"W"-1	5.9	1.8	1.6	1.1	1.0						
					Net Change	1.6	-0.4	-0.4	-0.4	-0.3						
					U_s Statistic	0	0	1	0	1						
	Final	6	10,200	3/19/69	Stock	5.7	1.9	1.5	1.3	1.1	3/19/69	5.7	1.9	1.5	1.3	1.1
				3/18/69	"W"-1	5.4	1.8	1.4	1.1	1.0	3/20/69	5.1	1.5	1.2	1.1	0.9
					Net Change	-0.3	-0.1	-0.1	-0.2	-0.1		-0.6	-0.4	-0.3	-0.2	-0.2
					U_s Statistic	1	*	*	*	*		0	0	0	1.5	*

---

*U_s Statistic greater than 2, no statistical difference apparent

TABLE 33. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "W"-1 VS STOCK MUFFLER

Vehicle: Bus 677 **Fuel: EM-70-F (No. 1 Diesel)**

Constant Speed (All open rack--maximum power output)

Operating Conditions	Vehicle Speed, mph	Test Date	Test Months	Test Miles	Load, hp		Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
					Stock	"W"-1	Stock	"W"-1	
	20	9/19, 20/68	0	0	45	45	8.7	8.3	0.4
		12/12/11/68	3	4,386	45	46	10.3	10.7	(0.4)*
(As received)		3/18, 19/69	6	10,200	47	44	11.0	11.8	(0.8)
(After regeneration)		3/19, 20/69	6		47	46	11.0	12.3	(1.3)
	25	9/19, 20/68	0	0	58	59	6.3	7.0	(0.7)
		12/12/11/68	3	4,386	60	60	8.0	8.3	(0.3)
(As received)		3/18, 19/69	6	10,200	62	62	8.0	9.0	(1.0)
(After regeneration)		3/19, 20/69	6		62	64	8.0	9.0	(1.0)
	30	9/19, 20/68	0	0	72	73	5.0	5.3	(0.3)
		12/12/11/68	3	4,386	73	73	6.7	6.0	0.7
(As received)		3/18, 19/69	6	10,200	77	74	5.7	7.0	(1.3)
(After regeneration)		3/19, 20/69	6		77	78	5.7	7.0	(1.3)
	35	9/19, 20/68	0	0	81	81	4.7	4.0	0.7
		12/12, 11/68	3	4,386	83	84	6.3	5.7	0.6
(As received)		3/18, 19/69	6	10,200	88	88	5.0	5.0	0
(After regeneration)		3/19, 20/69	6		88	90	5.0	5.0	0

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Test Date	Test Months	Test Miles	Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
				Stock	"W"-1	
Engine Start						
	9/19, 20/68	0	0	4.7	7.7	(3.0)
	12/12, 11/68	3	4,386	8.0	10.0	(2.0)
(As received)	3/18, 19/69	6	10,200	6.0	10.3	(4.3)
(After regeneration)	3/19, 20/69	6		6.0	6.0	0
During Acceleration						
	9/19, 20/68	0	0	4.0	5.0	(1.0)
	12/12, 11/68	3	4,386	6.7	7.0	(0.3)
(As received)	3/18, 19/69	6	10,200	6.3	7.0	(0.7)
(After regeneration)	3/19, 20/69	6		6.3	4.7	1.6
After Upshift						
	9/19, 20/68	0	0	4.3	5.0	(0.7)
	12/12/11/68	3	4,386	6.7	6.3	0.4
(As received)	3/18, 19/69	6	10,200	6.0	6.0	0
(After regeneration)	3/19, 20/69	6		6.0	6.0	0

---

*( ) indicates increase in smoke with catalytic muffler installed.

TABLE 34. OVERALL SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s ANALYSIS CATALYTIC MUFFLER CODE "W"-1 VS STOCK MUFFLER

Vehicle: Bus 677

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Months	Test Miles	Muffler Installed	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
20 mph 40 hp	9/20/68	0	0	Stock	394	4.21	1649	3	24	12	901		
	9/19/68			"W"-1	110	5.3	554	0	18	3	863		
	U_s Statistic				0	0	0	0	0	0	1.5		
	12/12/68	3	4,386	Stock	418	5.5	1328	3	22	8	878	1182	
	12/11/68			"W"-1	113	7.7	515	1	18	3	820	1035	
	U_s Statistic				0	0	0	0	2	0	1	0.5	
	3/19/69	6	10,200	Stock	388	3.8	1427	2	18	10	1011	1036	48
	3/18/69			"W"-1	181	4.3	696	1	14	3	940	970	14
	U_s Statistic				0	0	0	0	0	0	1	1	0
	3/19/69	(After regeneration)		Stock	388	3.8	1427	2	18	10	1011	1030	48
	3/20/69			"W"-1	165	4.6	380	0	9	4	861	938	59
	U_s Statistic				0	0	0	0	0	0	0	0	0
30 mph 40 hp	9/20/68	0	0	Stock	206	3.6	1648	2	23	7	785		
	9/19/68			"W"-1	99	4.2	595	0	15	3	620		
	U_s Statistic				0	0	0	0	0	0	*		
	12/12/68	3	4,386	Stock	250	4.6	1386	3	21	11	720	992	
	12/11/68			"W"-1	10[illegible]	5.2	480	1	19	1	788	980	
	U_s Statistic				0	*	0	0	*	0	0.5	*	
	3/19/69	6	16,200	Stock	210	3.1	1398	2	14	7	817	825	51
	3/18/69			"W"-1	73	3.6	702	1	12	3	858	860	13
	U_s Statistic				0	0	0	0	*	0	*	0	0
	3/19/69	(After regeneration)		Stock	210	3.1	1398	2	14	7	817	825	51
	3/20/69			"W"-1	108	3.6	543	0	9	3	762	850	36
	U_s Statistic				0	0	0	0	0	0	*	*	0
40 mph 40 hp	9/20/68	0	0	Stock	188	3.5	1630	2	22	11	670		
	9/19/68			"W"-1	94	4.1	573	0	15	3	658		
	U_s Statistic				0	0	0	0	0	0	*		
	12/12/68	3	4,386	Stock	218	4.8	1329	2	18	6	697	890	
	12/11/68			"W"-1	1[illegible]	4.4	582	1	20	2	705	945	
	U_s Statistic				0	*	0	0	2	0	*	*	
	3/19/69	6	10,200	Stock	175	2.9	1311	2	15	5	754	770	48
	3/18/69			"W"-1	69	3.2	679	1	11	4	739	770	12
	U_s Statistic				0	0	0	0	0	0	*	*	0
	3/19/69	(After regeneration)		Stock	210	3.1	1398	2	14	7	817	825	51
	3/20/69			"W"-1	108	3.6	543	0	9	3	762	850	36
	U_s Statistic				0	0	0	0	0	0	*	*	0
Idle	9/20/68	0	0	Stock	225	0.93	711	3	23	11	280		
	9/19/68			"W"-1	81	1.11	221	0	14	3	254		
	U_s Statistic				0	0	0	0	0	0	0	*	
	12/12/68	3	4,386	Stock	285	1.3	528	3	21	8	231	385	
	12/11/68			"W"-1	74	2.2	195	0	18	1	231	525	
	U_s Statistic				0	0	0	0	2	0	*	0	
	3/19/69	6	10,200	Stock	301	0.8	586	3	22	9	269	243	51
	3/18/69			"W"-1	76	1.0	197	1	15	4	263	268	13
	U_s Statistic				0	0	0	0	0	0	*	0	0
	3/19/69	(After regeneration)		Stock	301	0.8	586	3	22	9	269	243	51
	3/20/69			"W"-1	115	0.9	143	0	12	5	182	225	35
	U_s Statistic				0	1.5	0	0	0	0	0	*	0

---

*U_s Statistic greater than 2, no statistical difference apparent.

TABLE 35. MUFFLER PRESSURE AND TEMPERATURE SUMMARY CATALYTIC MUFFLER CODE "W"-1 VS STOCK MUFFLER

Vehicle: Bus 677

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Months	Test Miles		Muffler Pressure, in. H_2O			Muffler Temperature, °F			Air Box Pressure, in. Hg.
					Inlet	Outlet	Differential	Inlet	Outlet	Differential	
20 mph 40 hp	9/20/68	0	0	Stock	4.0	1.0	3.0	524	391	133	1.2
	9/19/68			"W"-1	2.3	0.9	1.4	591	455	136	1.3
	12/12/68	3	4,386	Stock	4.6	1.2	3.4	531	409	123	1.1
	12/11/68			"W"-1	9.8	2.2	7.5	600	421	179	1.4
	3/19/69	6	10,200	Stock	2.5	0.5	2.0	505	392	112	1.0
	3/18/69			"W"-1	5.0	1.0	4.0	575	370	205	1.3
	3/20/69	(After regeneration)		Stock	2.5	0.5	2.0	505	392	112	1.0
	3/19/69			"W"-1	2.0	1.0	1.0	552	435	117	1.0
30 mph 40 hp	9/20/68	0	0	Stock	6.5	1.7	4.8	511	394	118	2.3
	9/19/68			"W"-1	4.5	2.1	2.4	563	475	88	2.5
	12/12/68	3	4,386	Stock	6.8	2.0	4.7	509	411	98	2.2
	12/11/68			"W"-1	12.0	3.6	8.5	564	406	158	2.6
	3/19/69	6	10,200	Stock	4.5	0.5	4.0	490	395	95	2.0
	3/18/69			"W"-1	8.8	2.5	6.3	545	428	118	2.4
	3/20/69	(After regeneration)		Stock	4.5	0.5	4.0	490	395	95	2.0
	3/19/69			"W"-1	4.5	2.5	2.0	542	460	82	2.2
40 mph 40 hp	9/20/68	0	0	Stock	10.6	2.8	7.8	540	432	108	4.7
	9/19/68			"W"-1	8.4	4.6	3.8	561	529	33	4.6
	12/12/68	3	4,386	Stock	10.0	2.7	7.2	520	441	81	4.6
	12/11/68			"W"-1	18.2	6.6	11.5	564	449	115	4.7
	3/19/69	6	10,200	Stock	8.0	1.5	6.5	508	430	78	3.9
	3/18/69			"W"-1	15.5	5.4	9.9	560	460	98	4.2
	3/20/69	(After regeneration)		Stock	8.0	1.5	6.5	508	430	78	3.9
	3/19/69			"W"-1	8.5	5.1	3.5	545	499	46	4.2
Idle	9/20/68	0	0	Stock	0.8	0.2	0.6	281	310	(29)	0.6
	9/19/68			"W"-1	0.6	0.4	0.2	283	430	(148)	0.6
	12/12/68	3	4,386	Stock	0.8	0.2	0.6	275	294	(19)	0.7
	12/11/68			"W"-1	1.7	0.8	0.9	269	338	(69)	0.7
	3/19/69	6	10,200	Stock	0.8	0.2	0.6	255	280	(25)	0.7
	3/18/69			"W"-1	2.0	1.0	1.0	268	350	(83)	0.7
	3/20/69	(After regeneration)		Stock	0.8	0.2	0.6	255	280	(25)	0.7
	3/19/69			"W"-1	2.0	1.0	1.0	263	360	(98)	0.7

TABLE 36. OVERALL SUMMARY OF ODOR EVALUATIONS CATALYTIC MUFFLER "W"-2 VS STOCK MUFFLER

Vehicle: Bus 679
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Inspection Period	Test Months	Test Miles	Test Date	Muffler Installed	As-Received "D" Composite	As-Received "B" Burnt	As-Received "O" Oily	As-Received "A" Aromatic	As-Received "P" Pungent	Date	After Regeneration "D" Composite	After Regeneration "B" Burnt	After Regeneration "O" Oily	After Regeneration "A" Aromatic	After Regeneration "P" Pungent
20 mph 40 hp	Initial	0	0	9/20/68	Stock	4.9	1.6	1.3	1.1	0.8						
				9/19/68	"W"-2	4.6	1.2	0.9	0.9	0.9						
					Net Change	-0.3	-0.4	-0.4	-0.2	+0.1						
					U_x Statistic	*	2.0	1.5	*	*						
	Interim	3	4,004	12/18/68	Stock	5.5	1.7	1.3	1.0	1.0						
				12/17/68	"W"-2	5.2	1.6	1.1	1.0	1.0						
					Net Change	-0.3	-0.1	-0.2	0	0						
					U_x Statistic	*	*	0	*	*						
	Final	6	11,105	3/27/69	Stock	5.5	1.7	1.4	1.1	1.0	3/27/69	5.5	1.7	1.4	1.1	1.0
				3/26/69	"W"-2	4.7	1.5	1.0	1.0	0.8	3/28/69	4.1	1.1	1.0	0.8	0.7
					Net Change	-0.8	-0.2	-0.4	-0.1	-0.2		-1.4	-0.6	-0.4	-0.3	-0.3
					U_x Statistic	0	*	0.5	*	*		1	0	0	2	1.0
30 mph 40 hp	Initial	0	0	9/20/68	Stock	5.1	1.4	1.3	1.1	0.7						
				9/19/68	"W"-2	4.5	1.2	0.9	0.8	0.9						
					Net Change	-0.6	-0.2	-0.4	-0.3	+0.2						
					U_x Statistic	0.5	*	1.5	1.5	2						
	Interim	3	4,004	12/18/68	Stock	5.9	1.8	1.5	1.1	1.1						
				12/17/68	"W"-2	5.0	1.5	1.2	1.0	0.9						
					Net Change	-0.9	-0.3	-0.3	-0.1	-0.2						
					U_x Statistic	0	*	*	2	*						
	Final	6	11,105	3/27/69	Stock	5.4	1.8	1.3	1.1	0.8	3/27/69	5.4	1.8	1.3	1.1	0.8
				3/26/69	"W"-2	4.2	1.3	1.2	0.8	0.4	3/28/69	3.1	1.0	0.9	0.6	0.4
					Net Change	-1.2	-0.5	-0.1	-0.3	-0.4		-2.3	-0.8	-0.4	-0.5	-0.4
					U_x Statistic	0	1.0	*	0.5	0.5		0	0	0	0.5	0
40 mph 40 hp	Initial	0	0	9/20/68	Stock	5.4	1.8	1.5	1.1	0.8						
				9/19/68	"W"-2	5.0	1.4	1.1	1.0	0.9						
					Net Change	-0.4	-0.4	-0.4	-0.1	+0.1						
					U_x Statistic	2.0	0	1.5	*	*						
	Interim	3	4,004	12/18/68	Stock	5.9	1.8	1.6	1.0	1.0						
				12/17/68	"W"-2	4.8	1.3	1.2	1.0	0.9						
					Net Change	-1.1	-0.5	-0.4	0	-0.1						
					U_x Statistic	1	1	1.5	*	*						
	Final	6	11,105	3/27/69	Stock	5.6	1.8	1.4	1.1	0.9	3/27/69	5.6	1.8	1.4	1.1	0.9
				3/26/69	"W"-2	4.7	1.3	1.0	1.0	0.7	3/28/69	3.9	1.1	1.0	0.9	0.7
					Net Change	-0.9	-0.5	-0.4	-0.1	-0.2		-1.7	-0.7	-0.4	-0.2	-0.2
					U_x Statistic	1.5	1.5	0	2	*		0	0	0	0	*
Idle	Initial	0	0	9/20/68	Stock	6.0	1.9	1.6	1.1	1.0						
				9/19/68	"W"-2	3.9	1.2	0.9	0.8	0.7						
					Net Change	-2.1	-0.7	-0.7	-0.3	-0.3						
					U_x Statistic	0	0	0	1	0.5						
	Interim	3	4,004	12/18/68	Stock	6.1	1.9	1.4	1.3	1.0						
				12/17/68	"W"-2	5.3	1.6	1.3	1.0	0.9						
					Net Change	-0.8	-0.3	-0.1	-0.3	-0.1						
					U_x Statistic	0	0	*	2	*						
	Final	6	11,105	3/27/69	Stock	5.4	1.9	1.5	1.2	0.8	3/27/69	5.4	1.9	1.5	1.2	0.8
				3/26/69	"W"-2	4.4	1.2	1.0	1.0	0.5	3/28/69	3.5	1.0	1.0	0.9	0.5
					Net Change	-1.0	-0.7	-0.5	-0.2	-0.3		-1.9	-0.9	-0.5	-0.3	-0.3
					U_x Statistic	0	0	0	*	*		0.5	0	0	0	1.5
Idle-Acceleration	Initial	0	0	9/20/68	Stock	6.7	2.1	1.8	1.2	1.4						
				9/19/68	"W"-2	6.7	2.1	1.8	1.2	1.3						
					Net Change	0	0	0	0	-0.1						
					U_x Statistic	*	*	*	*	*						
	Interim	3	4,004	12/18/68	Stock	7.1	2.2	1.9	1.6	1.3						
				12/17/68	"W"-2	5.6	1.7	1.5	1.2	1.1						
					Net Change	-1.5	-0.5	-0.4	-0.4	-0.2						
					U_x Statistic	0	0	0	0	*						
	Final	6	11,105	3/27/69	Stock	6.1	2.0	1.7	1.3	1.3	3/27/69	6.1	2.0	1.7	1.3	1.3
				3/26/69	"W"-2	5.5	1.9	1.5	1.0	1.0	3/28/69	5.8	1.9	1.4	1.1	1.0
					Net Change	-0.6	-0.1	-0.2	-0.3	-0.3		-0.3	-0.1	-0.3	-0.2	-0.3
					U_x Statistic	2	*	*	2	*		*	*	*	2	*
Deceleration	Initial	0	0	9/20/68	Stock	7.1	2.2	1.9	1.3	1.6						
				9/19/68	"W"-2	6.2	1.9	1.6	1.2	1.2						
					Net Change	-0.9	-0.3	-0.3	-0.1	-0.4						
					U_x Statistic	1.5	0.5	2	*	1.5						
	Interim	3	4,004	12/18/68	Stock	6.1	1.8	1.6	1.3	1.0						
				12/17/68	"W"-2	4.7	1.2	1.2	1.0	0.8						
					Net Change	-1.4	-0.6	-0.4	-0.3	-0.2						
					U_x Statistic	0	0	0	0	1						
	Final	6	11,105	3/27/69	Stock	5.3	1.7	1.3	1.1	1.0	3/27/69	5.3	1.7	1.3	1.1	1.0
				3/26/69	"W"-2	3.8	1.1	1.0	0.9	0.5	3/28/69	4.1	1.2	0.9	0.8	0.6
					Net Change	-1.5	-0.6	-0.3	-0.2	-0.5		-1.2	-0.5	-0.4	-0.3	-0.4
					U_x Statistic	0	0	0	0.5	0		0	0	0	0.5	0

---

*U_x Statistic greater than 2, no statistical difference apparent.

TABLE 37. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "W"-2 VS STOCK MUFFLER

Vehicle: Bus 679

Fuel: EM-70-F (No. 1 Diesel)

Constant Speed (All open rack--maximum power output)

Operating Conditions	Vehicle Speed, mph	Test Date	Test Months	Test Miles	Load, hp		Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
					Stock	"W"-2	Stock	"W"-2	
	20	9/30 and 10/1/68	0	0	47	47	13.3	11.0	2.3
		12/18, 17/68	3	4,004	53	47	8.3	8.3	0
(As received)		3/26/27/69	6	11,105	46	46	7.0	7.0	0
(After regeneration)		3/27, 28/69	6		46	48	7.0	7.3	(0.3)*
	25	9/30 and 10/1/68	0	0	58	59	7.3	4.3	3.0
		12/18, 17/68	3	4,004	68	58	6.5	7.3	(0.8)
(As received)		3/26, 27/69	6	11,105	58	60	5.0	6.0	(1.0)
(After regeneration)		3/27, 28/69	6		58	60	5.0	6.0	(1.0)
	30	9/30 and 10/1/68	0	0	68	68	6.7	4.0	2.7
		12/18, 17/68	3	4,004	80	73	5.2	5.0	0.2
(As received)		3/26, 27/69	6	11,105	72	76	4.0	5.0	(1.0)
(After regeneration)		3/27, 28/69	6		72	74	4.0	4.0	0
	35	9/30 and 10/1/68	0	0	82	82	5.7	3.7	2.0
		12/18, 17/68	3	4,004	93	81	5.0	5.0	0
(As received)		3/26, 27/69	6	11,105	82	80	3.0	6.0	(3.0)
(After regeneration)		3/27, 28/69	6		82	82	3.0	5.7	(2.7)

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Test Date	Test Months	Test Miles	Average PHS Smoke Reading, Percent Opacity		Smoke Reduction, Percent Opacity
				Stock	"W"-2	
Engine Start						
	9/30 and 10/1/68	0	0	8.7	9.7	(1.0)
	12/18, 17/68	3	4,004	5.3	10.0	(4.7)
(As received)	3/26, 27/69	6	11,105	7.3	6.0	1.3
(After regeneration)	3/27, 28/69	6		7.3	9.7	(2.4)
During Acceleration						
	9/30 and 10/1/68	0	0	6.0	4.3	1.7
	12/18, 17/68	3	4,004	5.0	6.0	(1.0)
(As received)	3/26, 27/69	6	11,105	5.0	4.5	0.5
(After regeneration)	3/27, 28/69	6		5.0	5.0	0
After Upshift						
	9/30 and 10/1/68	0	0	6.0	4.0	2.0
	12/18, 17/68	3	4,004	4.0	6.7	(2.7)
(As received)	3/26, 27/69	6	11,105	3.0	3.0	0
(After regeneration)	3/27, 28/68	6		3.0	4.0	(1.0)

---

*( ) indicates increase in smoke with catalytic muffler installed.

TABLE 38. OVERALL SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s ANALYSIS CATALYTIC MUFFLER CODE "W"-2 VS STOCK MUFFLER

Vehicle: Bus 679

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Months	Test Miles	Muffler Installed	Average "As-Measured" Exhaust Emissions								
					CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
20 mph 40 hp	10/1/68	0	0	Stock	781	4.1	1481	3	24	12	918		
	9/30/68			"W"-2	288	5.2	328	1	20	6	924		
	U_s Statistic				0	0	0	0	0	0	*		
	12/18/68	3	4,004	Stock	388	5.2	1705	3	21	6	1120	1215	
	12/17/68			"W"-2	153	8.6	704	1	15	5	771	1113	
	U_s Statistic				0	0	0	0	0	*	0	2	
	3/27/69	6	11,105	Stock	350	3.8	1091	2	25	7	1091	1130	41
	3/26/69			"W"-2	158	4.3	551	2	24	7	1040	820	22
	U_s Statistic				0	0	0	*	*	*	*	0	0
	3/27/69	(After regeneration)		Stock	350	3.8	1091	2	25	7	1091	1130	41
	3/28/69			"W"-2	140	4.23	555	1	14	4	904	750	23
	U_s Statistic				0	0	0	0	0	0	0	0	0
30 mph 40 hp	10/1/68	0	0	Stock	263	3.5	1420	2	20	8	780		
	9/30/68			"W"-2	113	4.3	300	0	16	3	777		
	U_s Statistic				0	0	0	0	0	0	*		
	12/18/68	3	4,004	Stock	190	4.2	1536	3	19	6	751	913	
	12/17/68			"W"-2	98	6.9	1014	1	15	4	826	1028	
	U_s Statistic				0	0	0	0	0	0	0	1	
	3/27/69	6	11,105	Stock	214	3.0	945	2	22	7	907	878	40
	3/26/69			"W"-2	99	3.2	534	1	18	4	811	725	21
	U_s Statistic				0	*	0	0	2	0	*	0	0
	3/27/69	(After regeneration)		Stock	214	3.0	945	2	22	7	907	878	40
	3/28/69			"W"-2	123	3.39	571	0	13	3	725	600	19
	U_s Statistic				0	0	0	0	0	0	0	0	0
40 mph 40 hp	10/1/68	0	0	Stock	250	3.3	1279	2	20	6	722		
	9/30/68			"W"-2	106	4.0	308	0	17	3	661		
	U_s Statistic				0	0	0	0	0	0	0		
	12/18/68	3	4,004	Stock	175	4.1	1385	2	19	6	693	885	
	12/17/68			"W"-2	88	6.1	820	1	13	5	670	910	
	U_s Statistic				0	0	0	0	0	1	*	*	
	3/27/69	6	11,105	Stock	190	2.8	864	2	17	7	771	738	38
	3/26/69			"W"-2	95	2.8	453	1	18	2	748	615	17
	U_s Statistic				0	*	0	0	*	0	*	1.5	0
	3/27/69	(After regeneration)		Stock	190	2.8	864	2	17	7	771	738	38
	3/28/69			"W"-2	123	3.06	513	0	13	3	655	519	13
	U_s Statistic				0	2	0	0	0	0	1	0	0
Idle	10/1/68	0	0	Stock	306	1.0	580	3	24	10	289		
	9/30/68			"W"-2	75	1.1	121	0	16	4	228		
	U_s Statistic				0	1	0	0	0	0	0		
	12/18/68	3	4,004	Stock	233	1.0	519	3	23	10	191	315	
	12/17/68			"W"-2	89	1.6	285	1	15	7	165	340	
	U_s Statistic				0	0	0	0	0	0	*	*	
	3/27/69	6	11,105	Stock	235	0.6	337	3	30	13	254	209	43
	3/26/69			"W"-2	148	0.7	151	1	19	6	197	160	25
	U_s Statistic				0	*	0	0	0	0	2	2	0
	3/27/69	(After regeneration)		Stock	235	0.6	337	3	30	13	254	209	43
	3/28/69			"W"-2	108	0.65	133	0	15	4	159	169	16
	U_s Statistic				0	0	0	0	0	0	0	1.5	0

---

*U_s Statistic greater than 2, no statistical difference apparent.

TABLE 39. MUFFLER PRESSURE AND TEMPERATURE SUMMARY CATALYTIC MUFFLER CODE "W"-2 STOCK MUFFLER

Vehicle: Bus 679

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Months	Test Miles		Muffler Pressure, in. H_2O			Muffler Temperature, °F			Air Box Pressure, in. Hg.
					Inlet	Outlet	Differential	Inlet	Outlet	Differential	
20 mph	10/1/68	0	0	Stock	4.4	1.0	3.4	528	410	118	1.2
40 hp	9/30/68			"W"-2	4.6	2.0	2.6	592	458	133	1.3
	12/18/68	3	4,004	Stock	4.3	1.0	3.3	510	389	124	1.2
	12/17/68			"W"-2	6.7	1.8	4.9	589	458	131	1.2
	3/27/69	6	11,105	Stock	2.6	0.1	2.1	530	385	143	1.1
	3/26/69			"W"-2	4.0	1.0	3.0	625	475	150	1.3
	3/28/69	(After regeneration)		Stock	2.6	0.1	2.1	530	585	143	1.1
	3/27/69			"W"-2	3.4	1.0	2.4	585	448	138	1.3
30 mph	10/1/68	0	0	Stock	6.8	1.6	5.2	508	415	93	2.6
40 hp	9/30/68			"W"-2	7.6	4.0	3.6	544	493	51	2.5
	12/18/68	3	4,004	Stock	7.2	2.0	5.2	496	389	110	2.3
	12/17/68			"W"-2	13.1	6.0	7.0	535	453	108	2.2
	3/27/69	6	11,105	Stock	5.0	1.0	3.5	520	419	103	2.2
	3/26/69			"W"-2	7.3	2.5	4.5	573	490	83	2.5
	3/28/69	(After regeneration)		Stock	5.0	1.0	3.5	520	419	103	2.2
	3/27/69			"W"-2	6.1	2.5	3.9	563	494	69	2.5
40 mph	10/1/68	0	0	Stock	11.0	2.6	8.4	529	438	91	4.8
40 hp	9/30/68			"W"-2	12.6	6.9	5.8	553	523	30	4.7
	12/18/68	3	4,004	Stock	11.1	3.0	8.0	514	433	85	4.2
	12/17/68			"W"-2	16.8	6.0	10.7	540	495	45	4.8
	3/27/69	6	11,105	Stock	8.5	2.0	6.5	545	453	93	4.6
	3/26/69			"W"-2	12.4	5.1	7.0	563	510	53	4.6
	3/28/69	(After regeneration)		Stock	8.5	2.0	6.5	545	453	93	4.6
	3/27/69			"W"-2	10.9	5.0	5.9	595	541	54	4.8
Idle	10/1/68	0	0	Stock	0.8	0.2	0.6	285	316	(31)	0.6
	9/30/68			"W"-2	0.7	0.55	0.18	274	428	(154)	0.6
	12/18/68	3	4,004	Stock	0.8	0.4	0.4	263	288	(25)	0.5
	12/17/68			"W"-2	1.4	0.8	0.6	260	391	(132)	0.7
	3/27/69	6	11,105	Stock	0	0	0	283	323	(40)	0.7
	3/26/69			"W"-2	0	0	0	250	373	(123)	0.7
	3/28/69	(After regeneration)		Stock	0	0	0	283	323	(40)	0.7
	3/27/69			"W"-2	0	0	0	283	393	(110)	0.7

TABLE 40. OVERALL SUMMARY OF ODOR EVALUATIONS CATALYTIC MUFFLER "W"-3 VS STOCK MUFFLER

Vehicle: Bus 681
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Inspection Period	Test Months	Test Miles	Test Date	Muffler Installed	As-Received						After Regeneration				
						"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent	Date	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph 40 hp	Initial	0	0	10/10/68	Stock	5.7	1.7	1.5	1.1	1.0						
				10/ 9/68	"W"-3	5.2	1.6	1.4	0.9	1.0						
					Net Change	0.5	0.1	0.1	0.2	0						
					U_s Statistic	0	*	*	1	*						
	Interim	3	4,709	1/7/69	Stock	4.9	1.3	1.1	1.0	1.0	1/17/69	4.8	1.4	1.1	1.0	1.0
				1/6/69	"W"-3	5.2	1.7	1.2	1.1	0.9	1/16/69	4.8	1.4	1.0	1.0	1.0
					Net Change	+0.3	+0.4	+0.1	+0.1	0.1		0	0	0.1	0	0
					U_s Statistic	*	2	*	2	*		*	*	*	*	*
	Final	6	10,750	4/2/69	Stock	4.8	1.5	1.2	1.1	0.8	4/2/69	4.8	1.5	1.2	1.1	0.8
				4/1/69	"W"-3	4.6	1.3	1.0	1.0	0.6	4/3/69	4.5	1.2	1.1	0.9	0.8
					Net Change	0.2	0.2	0.2	0.1	0.2		0.3	0.3	0.1	0.2	0
					U_s Statistic	*	*	*	*	*		*	*	*	*	*
30 mph 40 hp	Initial	0	0	10/10/68	Stock	5.6	1.8	1.5	1.1	1.0						
				10/ 9/68	"W"-3	4.6	1.3	1.2	0.7	0.8						
					Net Change	1.0	0.5	0.3	0.4	0.2						
					U_s Statistic	1.5	1.5	1.5	0	1						
	Interim	3	4,709	1/7/69	Stock	5.3	1.6	1.3	1.0	1.0	1/17/69	5.4	1.7	1.2	1.1	1.0
				1/6/69	"W"-3	5.5	1.7	1.3	1.1	0.8	1/16/69	4.0	1.2	1.0	0.9	0.9
					Net Change	+0.2	+0.1	0	+0.1	0.2		1.4	0.5	0.2	0.2	0.1
					U_s Statistic	*	*	*	2	0		0	0.5	1.5	*	*
	Final	6	10,750	4/2/69	Stock	4.7	1.4	1.2	1.1	0.7	4/2/69	4.7	1.4	1.2	1.1	0.7
				4/1/69	"W"-3	3.7	1.1	0.9	0.9	0.5	4/3/69	4.3	1.3	1.0	0.9	0.6
					Net Change	1.0	0.3	0.3	0.1	0.2		0.4	0.1	0.2	0.2	0.1
					U_s Statistic	0	1	1	*	*		2	*	*	*	*
40 mph 40 hp	Initial	0	0	10/10/68	Stock	5.9	1.7	1.5	1.1	1.1						
				10/ 9/68	"W"-3	3.9	1.3	1.1	0.7	0.6						
					Net Change	2.0	0.4	0.4	0.4	0.5						
					U_s Statistic	0	0.5	0	0	0.5						
	Interim	3	4,709	1/7/69	Stock	5.2	1.6	1.4	1.0	1.0	1/17/69	5.0	1.4	1.2	1.0	1.0
				1/6/69	"W"-3	5.3	1.7	1.3	1.1	0.8	1/16/69	3.9	1.2	0.9	0.9	0.7
					Net Change	+0.1	+0.1	0.1	+0.1	0.2		1.1	0.2	0.3	0.1	0.3
					U_s Statistic	*	*	*	0	1		0	0	0	*	0
	Final	6	10,750	4/2/69	Stock	5.0	1.6	1.2	1.1	0.7	4/2/69	5.0	1.6	1.2	1.1	0.7
				4/1/69	"W"-3	4.3	1.2	1.0	1.0	0.6	4/3/69	4.0	1.2	1.0	0.9	0.5
					Net Change	0.7	0.4	0.2	0.1	0.1		1.0	0.4	0.2	0.2	0.2
					U_s Statistic	2	1	1	*	*		2	1	*	1	2
Idle	Initial	0	0	10/10/68	Stock	5.8	1.7	1.6	1.1	1.0						
				10/ 9/68	"W"-3	3.1	1.1	1.0	0.6	0.5						
					Net Change	2.7	0.6	0.6	0.5	0.5						
					U_s Statistic	0	0	0	0	0.5						
	Interim	3	4,709	1/7/69	Stock	5.8	1.9	1.6	1.0	1.0	1/17/69	5.9	1.9	1.5	1.1	1.3
				1/6/69	"W"-3	6.3	2.0	1.6	1.2	0.9	1/16/69	4.2	1.3	1.1	1.0	0.8
					Net Change	+0.5	+0.1	0	+0.2	0.1		1.7	0.6	0.4	0.1	0.5
					U_s Statistic	2	*	*	0.5	*		1	0	2	*	2
	Final	6	10,750	4/2/69	Stock	5.3	1.7	1.2	1.1	0.9	4/2/69	5.3	1.7	1.2	1.1	0.9
				4/1/69	"W"-3	4.0	1.1	1.0	0.9	0.4	4/3/69	4.4	1.4	1.1	1.0	0.7
					Net Change	1.3	0.6	0.2	0.2	0.5		0.9	0.3	0.1	0.1	0.2
					U_s Statistic	0	0	1	*	*		0	*	*	*	2
Idle-Acceleration	Initial	0	0	10/10/68	Stock	7.1	2.3	2.0	1.2	1.4						
				10/ 9/68	"W"-3	6.4	2.1	1.8	1.3	1.1						
					Net Change	0.7	0.2	0.2	+0.1	0.3						
					U_s Statistic	1	*	*	*	1						
	Interim	3	4,709	1/7/69	Stock	6.3	2.0	1.9	1.0	1.1	1/17/69	6.6	2.0	1.9	1.2	1.3
				1/6/69	"W"-3	5.9	2.0	1.7	1.0	1.2	1/16/69	5.5	1.9	1.6	1.1	1.0
					Net Change	0.4	0	0.2	0	+0.1		1.1	0.1	0.3	0.1	0.3
					U_s Statistic	*	*	1	*	*		0	1.5	1	8	1.5
	Final	6	10,750	4/2/69	Stock	6.6	2.0	1.8	1.5	1.0	4/2/69	6.6	2.0	1.8	1.5	1.0
				4/1/69	"W"-3	5.0	1.5	1.2	1.0	0.9	4/3/69	5.3	1.7	1.2	1.1	0.9
					Net Change	1.6	0.5	0.6	0.5	0.1		1.3	0.3	0.6	0.4	0.1
					U_s Statistic	0	0	0	0	1.5		0	0	1	0	*
Deceleration	Initial	0	0	10/10/68	Stock	7.5	2.5	2.1	1.3	1.6						
				10/ 9/68	"W"-3	5.7	1.9	1.5	1.2	1.1						
					Net Change	1.8	0.6	0.6	0.1	0.5						
					U_s Statistic	0	0	0	*	0						
	Interim	3	4,709	1/7/69	Stock	6.9	2.5	2.0	1.3	1.1	1/17/69	6.8	2.1	1.9	1.2	1.5
				1/6/69	"W"-3	6.0	2.0	1.7	1.2	1.1	1/16/69	5.9	1.9	1.7	1.4	1.1
					Net Change	0.9	0.5	0.3	0.1	0		0.9	0.2	0.2	+0.2	0.4
					U_s Statistic	0	0	0	*	*		0	2	0.5	*	0
	Final	6	10,750	4/2/69	Stock	7.1	2.1	1.8	1.6	1.1	4/2/69	7.1	2.1	1.8	1.6	1.1
				4/1/69	"W"-3	5.3	1.7	1.5	1.1	0.9	4/3/69	5.5	1.7	1.2	1.3	0.8
					Net Change	1.8	0.4	0.3	0.5	0.2		1.6	0.2	0.6	0.3	0.3
					U_s Statistic	0	0	*	1	*		0	1	1.5	*	0

---

*U_s Statistic greater than 2, no statistical difference apparent.

TABLE 41. COMPARISON OF SMOKE FROM CATALYTIC MUFFLER CODE "W"-3 VS STOCK MUFFLER

Vehicle: Bus 681

Fuel: EM-70-F (No. 1 Diesel)

Constant Speed (All open rack--maximum power output)

Operating Conditions	Vehicle Speed, mph	Test Date	Test Months	Test Miles	Load, hp Stock	Load, hp "W"-3	Average PHS Smoke Reading, Percent Opacity Stock	Average PHS Smoke Reading, Percent Opacity "W"-3	Smoke Reduction, Percent Opacity
	20	10/9, 10/68	0	0	49	49	3.3	3.0	0.3
(As received)		1/7, 6/69	3	4,709	58	56	5.7	7.0	(1.3)*
(After regeneration)		1/17, 16/69	3	5,250	55	57	7.3	11.3	(4.0)
(As received)		4/1, 2/69	6	10,750	50	46	5.0	6.3	(1.3)
(After regeneration)		4/2, 3/69	6		50	48			
	25	10/9, 10/68	0	0	60	60	2.0	3.0	(1.0)
(As received)		1/7, 6/69	3	4,709	64	74	4.0	4.3	(0.3)
(After regeneration)		1/17, 16/69	3	5,250	70	65	5.3	10.0	(4.7)
(As received)		4/1, 2/69	6	10,750	62	62	4.0	5.0	(1.0)
(After regeneration)		4/2, 3/69	6		62	62			
	30	10/9, 10/68	0	0	74	75	2.0	2.0	0
(As received)		1/7, 6/69	3	4,709	86	80	3.3	2.7	0.6
(After regeneration)		1/17, 16/69	3	5,250	80	78	4.3	5.0	(0.7)
(As received)		4/1, 2/69	6	10,750	76	74	3.0	4.0	(1.0)
(After regeneration)		4/2, 3/69	6		76	72			
	35	10/9, 10/68	0	0	80	80	2.0	2.0	0
(As received)		1/7, 6/69	3	4,709	98	94	3.0	2.3	(0.7)
(After regeneration)		1/17, 16/69	3	5,250	100	91	4.0	5.0	(1.0)
(As received)		4/1, 2/69	6	10,750	84	82	2.7	3.7	(1.0)
(After regeneration)		4/2, 3/69	6		84	82			

Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of Idle-Acceleration	Test Date	Test Months	Test Miles	Average PHS Smoke Reading, Percent Opacity Stock	Average PHS Smoke Reading, Percent Opacity "W"-3	Percent Opacity
Engine Start						
	10/9, 10/68	0	0	2.7	2.0	0.7
(As received)	1/7, 6/69	3	4,709	3.0	3.3	(0.3)
(After regeneration)	1/17, 16/69	3	5,250	2.3	3.7	(1.4)
(As received)	4/1, 2/69	6	10,750	3.0	4.0	(1.0)
(After regeneration)	4/2, 3/69	6				
During Acceleration						
	10/9, 10/68	0	0	2.0	3.7	(1.7)
(As received)	1/7, 6/69	3	4,709	2.0	3.7	(1.7)
(After regeneration)	1/17, 16/69	3	5,250	2.3	4.0	(1.7)
(As received)	4/1, 2/69	6	10,750	2.0	4.0	(2.0)
(After regeneration)	4/2, 3/69	6				
After Upshift						
	10/9, 10/68	0	0	2.0	3.0	(1.0)
(As received)	1/7, 6/69	3	4,709	2.7	3.7	(1.0)
(After regeneration)	1/17, 16/69	3	5,250	3.0	4.7	(1.7)
(As received)	4/1, 2/69	6	10,750	2.0	3.0	(1.0)
(After regeneration)	4/2, 3/69	6				

---

*( ) indicates increase in smoke with catalytic muffler installed.

TABLE 42. OVERALL SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s ANALYSIS CATALYTIC MUFFLER CODE "W"-3 VS STOCK MUFFLER

Vehicle: Bus 681 **Fuel:** EM-70-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Months	Test Miles	Muffler Installed	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
20 mph 40 hp	10/10/68	0	0	Stock	213	3.38	2145	2	19	4	1016		
	10/9/68			"W"-3	84	3.06	469	1	27	5	892		
	U_s Statistic				0	*	0	*	0	*	0		
	1/7/69	3	4,709	Stock	155	3.08	1855	2	19	5	1115	1350	
	1/6/69			"W"-3	64	3.30	1910	1	27	4	930	1350	
	U_s Statistic				0	1	*	0	0	*	0	*	
	1/17/69			Stock	225	3.0	2141	1	13	5	1005	903	
	1/16/69			"W"-3	107	3.2	1333	1	13	4	849	839	
	U_s Statistic				0	*	0	0	*	0	2	*	
	4/2/69	6	10,750	Stock	213	3.3	1467	2	21	5	1011	836	40
	4/1/69			"W"-3	149	4.1	1154	1	17	5	855		17
	U_s Statistic				0.5	0	1	2	*	*	0	-	0
	4/2/69			Stock	213	3.3	1467	2	21	5	1011	836	40
	4/3/69			"W"-3	119	3.9	847	1	11	4	739	770	17
	U_s Statistic				0	0	1	0	0	0.5	0	0	0
30 mph 40 hp	10/10/68	0	0	Stock	219	2.8	2213	2	19	5	736		
	10/9/68			"W"-3	66	2.34	960	1	23	4	653		
	U_s Statistic				0	0	0	0	0	*	0		
	1/7/69	3	4,709	Stock	141	2.5	1804	2	19	4	750	995	
	1/6/69			"W"-3	59	2.9	2000	1	21	4	662	1198	
	U_s Statistic				0	0	0	0	*	*	*	0	
	1/17/69			Stock	204	2.6	2228	2	15	5	684	615	42
	1/16/69			"W"-3	82	2.6	1614	1	15	4	785	716	15
	U_s Statistic				0	*	0	0	*	*	1	0	
	4/2/69	6	10,750	Stock	176	2.7	1549	2	21	4	699	600	42
	4/1/69			"W"-3	111	3.2	1242	1	13	4	658		15
	U_s Statistic				0	0	2	0	0	*	*	-	0
	4/2/69			Stock	176	2.7	1549	2	21	4	699	600	42
	4/3/69			"W"-3	104	3.1	893	1	11	4	621	563	17
	U_s Statistic				0	0	0	0	0	*	0	0	0
40 mph 40 hp	10/10/68	0	0	Stock	198	2.61	2000	2	20	5	638		
	10/9/68			"W"-3	36	2.40	688	1	19	4	554		
	U_s Statistic				0	1	0	0	*	2	0		
	1/7/69	3	4,709	Stock	141	2.45	1769	2	19	5	684	833	
	1/6/69			"W"-3	40	2.56	1475	1	20	4	549	930	
	U_s Statistic				0	*	0	0	*	1	0	0.5	
	1/17/69			Stock	200	2.50	1995	1	13	4	609	590	
	1/16/69			"W"-3	65	2.66	1081	0	10	4	566	533	
	U_s Statistic				0	*	0	0	0	*	*	*	
	4/2/69	6	10,750	Stock	158	2.7	1334	2	21	5	630	530	40
	4/1/69			"W"-3	98	2.9	946	1	12	3	529		14
	U_s Statistic				0	1.5	0	0	0	0	0	-	0
	4/2/69			Stock	158	2.7	1334	2	21	5	630	530	40
	4/3/69			"W"-3	104	2.8	754	1	11	3	488	410	17
	U_s Statistic				0	*	0	0	0	0	0	0	0
Idle	10/10/68	0	0	Stock	244	0.7	599	2	19	7	271		
	10/9/68			"W"-3	33	0.45	190	1	19	4	182		
	U_s Statistic				0	0	0	0	*	0	0		
	1/7/69	3	4,709	Stock	[illegible]	0.55	531	2	20	7	234	279	
	1/6/69			"W"-3	[illegible]	0.81	484	1	19	4	173	288	
	U_s Statistic				0	0	2	0	*	0	1.5	*	
	1/17/69			Stock	230	0.7	615	2	22	8	176	410	
	1/16/69			"W"-3	47	0.7	208	1	15	5	165	253	
	U_s Statistic				0	*	0	0	0	0	*	2	
	4/2/69	6	10,750	Stock	216	0.6	499	3	26	8	208	175	46
	4/1/69			"W"-3	128	0.7	302	1	18	7	145		16
	U_s Statistic				0	*	0	0	0	*	0	-	0
	4/2/69			Stock	216	0.6	499	3	26	8	208	175	46
	4/3/69			"W"-3	128	0.7	290	1	14	4	127	141	17
	U_s Statistic				0	*	0	0	0	0	0	2	0

---

*U_s Statistic greater than 2, no statistical difference apparent.

TABLE 43. MUFFLER PRESSURE AND TEMPERATURE SUMMARY CATALYTIC MUFFLER CODE "W"-3 VS STOCK MUFFLER

Vehicle: Bus 681

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Test Date	Test Months	Test Miles		Muffler Pressure, in. H_2O			Muffler Temperature, °F			Air Box Pressure in. Hg.
					Inlet	Outlet	Differential	Inlet	Outlet	Differential	
20 mph	10/10/68	0	0	Stock	4.8	0.9	3.8	502	395	107	1.0
40 hp	10/9/68			"W"-3	4.2	2.4	2.0	565	483	83	1.3
	1/7/69	3	4,709	Stock	8.3	3.2	5.1	515	378	138	1.0
	1/6/69			"W"-3	6.0	1.8	4.1	545	435	115	1.2
	1/17/69	(After regeneration)		Stock	4.2	1.2	3.1	513	403	110	1.0
	1/16/69			"W"-3	6.2	1.8	4.4	555	420	135	1.0
	4/2/69	6	10,750	Stock	2.6	0.6	2.0	523	420	103	1.2
	4/1/69			"W"-3	4.0	0.9	3.0	583	463	120	1.1
	4/2/69	(After regeneration)		Stock	2.6	0.6	2.0	523	420	103	1.2
	4/3/69			"W"-3	2.8	1.0	1.8	600	473	128	1.4
30 mph	10/10/68	0	0	Stock	7.2	1.5	5.6	478	393	86	2.4
40 hp	10/9/68			"W"-3	6.5	3.8	2.8	523	480	43	2.5
	1/7/69	3	4,709	Stock	8.4	1.8	6.6	490	385	105	1.8
	1/6/69			"W"-3	8.5	2.6	5.8	526	435	91	2.2
	1/17/69	(After regeneration)		Stock	6.6	2.0	4.6	479	383	96	1.9
	1/16/69			"W"-3	9.6	3.1	6.6	520	395	125	1.9
	4/2/69	6	10,750	Stock	5.0	1.0	4.0	500	423	80	2.3
	4/1/69			"W"-3	7.0	2.0	5.0	538	488	50	2.2
	4/2/69	(After regeneration)		Stock	5.0	1.0	4.0	500	433	80	2.3
	4/3/69			"W"-3	5.0	2.1	2.8	560	463	98	2.4
40 mph	10/10/68	0	0	Stock	11.8	2.5	9.1	501	414	88	4.8
40 hp	10/9/68			"W"-3	11.7	7.6	4.2	534	530	4	4.8
	1/7/69	3	4,709	Stock	11.2	2.2	9.0	505	415	90	3.8
	1/6/69			"W"-3	15.4	6.3	9.1	518	490	28	4.0
	1/17/69	(After regeneration)		Stock	10.4	3.0	7.5	515	440	75	4.0
	1/16/69			"W"-3	14.0	6.0	8.0	530	488	43	3.5
	4/2/69	6	10,750	Stock	8.5	2.0	6.5	525	455	70	4.5
	4/1/69			"W"-3	13.4	4.5	8.3	540	538	50	4.6
	4/2/69	(After regeneration)		Stock	8.5	2.0	6.5	525	455	70	4.5
	4/3/69			"W"-3	10.0	5.0	5.0	558	508	50	4.5
Idle	10/10/68	0	0	Stock	1.0	0.2	0.6	279	311	33	0.6
	10/9/68			"W"-3	0.8	0.6	0.2	273	417	(145)	0.5
	1/7/69	3	4,709	Stock	4.0	0.6	3.4	275	308	(33)	0.7
	1/6/69			"W"-3	2.4	1.1	1.4	260	368	(108)	0.6
	1/17/69	(After regeneration)		Stock	3.6	0.4	3.2	288	323	(35)	0.6
	1/16/69			"W"-3	1.4	0.8	0.6	280	433	(153)	0.6
	4/2/69	6	10,750	Stock	0	0	0	258	290	(33)	0.8
	4/1/69			"W"-3	1.0	0	0.8	238	390	(143)	0.7
	4/2/69	(After regeneration)		Stock	0	0	0	258	290	(33)	0.8
	4/3/69			"W"-3	0.5	0	0	250	383	(133)	0.8

3. Cost Effectiveness

Consideration was given to determining the cost effectiveness of this device. Although the base cost for the stainless steel configuration of the Code "W" unit is known, it is premature to estimate the cost of the hardware items required in commercial application. As previously mentioned, there are currently three design drawbacks with the "W" device configuration (exhaust flow capacity, vertical installation, and sound suppression), each of which would need consideration in a redesign of the device. More importantly, however, is the determination of the need of regeneration. Considerations not only include space available for the regeneration equipment but safety aspects, since such a device would be used continuously or semicontinuously in a public transportation vehicle. Because of the hazards involved in determining future costs of installation for the capital equipment items and operating costs due to regeneration, it is too soon to determine a cost effectiveness ratio for this approach.

From an operating standpoint, the 6-month test did not indicate any operating costs over that with the stock muffler. Of course, compressed air and diesel fuel used for regeneration could become important depending on their use rate. On a 6-month basis, these costs are negligible, but on a continuous basis, the regeneration becomes one of direct flame afterburning and could depreciate the excellent fuel economy of the diesel. The addition of the Code "W" unit and its operation for 6 months did not affect the basic engine in either operating costs for fuel and lube or maintenance. This is shown in Tables 97, 98, and 99 of Appendix B. A similar group of three buses powered by the same engines and operated similarly but with stock muffler is also listed for comparison purposes.

4. Summary

In summary, a catalytic muffler has been operated on three municipal buses for 6 months during which time periodic tests were conducted to determine the device's ability to reduce odor, smoke, and other emissions. Odor reductions were achieved generally about half the time under most conditions except idle and the 20-mph cruise. Though the catalyst was ineffective on visible smoke, it was significant in reducing hydrocarbons and CO.

V. BUS ODOR AND SMOKE VARIABILITY

During the Part I studies (Ref. 1), the odor and smoke from ten similar GM Truck and Coach Division Model TDH 4519 buses was made. These units were powered by Detroit Diesel Division GMC 6V-71 E type, two-cycle, two-valve engines equipped with type 60S injectors. Until several years ago, this type engine was predominately used in municipal coach service. Within the past several years, the N version of this engine has been used almost exclusively, which features a higher compression ratio (18.7:1 versus 17.0:1) and improved fuel injection characteristics. Reports from the field, as well as limited, single-vehicle evaluations by SwRI as part of the Part II program, indicated that the exhaust odor and smoke characteristics were different from the N type engine relative to the older E type engine, even though both engines were of the two-valve configuration and equipped with type 60 injectors, S injectors for the E engine and N type injectors for the N engine. These indications and reports prompted a more complete investigation of the odor and smoke characteristics with the improved engine such that not only the baseline data variability could be established but a more valid comparison of the N engine to the E engine could be made.

A. Objective

The objective was to acquire odor and smoke data on a similar group of ten vehicles powered by the newer N type engine. The variability of the data would then be studied and compared to odor and smoke from the ten E buses.

B. Preparations

The ten vehicles were arbitrarily selected from a group of thirty, all purchased in April 1966 and similar in every detail to the previously investigated E buses with the exception of the engine. These 45-passenger buses all had the same rear axle ratio, two-speed Allison transmission, with the exhaust muffler located under the coach, and were not hand-selected but were obtained as a block of vehicles according to bus number. No maintenance or other type of preparation prior to test was performed. The mileage accumulation during the approximately 2 yr of routine municipal bus service and maintenance by the San Antonio Transit System were approxmately the same, ranging from 121, 359 to 137, 516. Each of the ten buses were equipped with the Jacobs Engine/Vehicle Retarder device during February 1968. However, the Jacobs Brake device was disconnected and inoperative during the smoke and odor evaluation. For additional information regarding pertinent engine maintenance history, such as date and mileage of injector check, major engine maintenance, tune-up, etc., please refer to Table 1 of Appendix C.

The approach used to obtain the baseline data was identical to that employed 2 years before during Part I, namely, to evaluate the odor and then the smoke from each bus on a single day and to operate a different bus each day in succession, with the exception of weekends. The evaluation conditions employed for both odor and smoke were identical to those used previously and are listed on Tables 2 and 13 of Appendix C.

The fuel utilized was a commercial No. 1 kerosene type diesel fuel typical of that normally used by the San Antonio Transit System and other transit authorities. The inspection results for this fuel, SwRI code EM-70-F, are shown on Table 2 and may be compared to the EM-3-F originally used in the original E bus study. The distillation range appears to be slightly higher for EM-70-F than for EM-3-F. Also, the cetane number appears to be about three numbers higher. The FIA analysis is about the same, although the EM-70-F inspection listed no olefins, while 2.5-percent olefins were in the EM-3-F. Total sulfur in both cases was less than 0.1 percent by weight.

Except for the slight differences in fuel composition noted above and the approximately 1-1/2 years' time lapse between determinations, the only significant variable was engine type. The SwRI sensory panel, comprised mostly of the original panel plus newly trained panelists, had been functioning for a sufficient time to be as proficient during this study as the original variability study. Also, those odor kit materials which appeared to have lost strength had previously been replaced with new materials. The same 100:1 dilution of the exhaust was employed throughout.

C. Odor Results

The odor results are listed on Table 44 for all ten N buses. The E bus results, from the Part I final report (Reference 1) are reprinted as Table 45. The N and E odor data are compared on

TABLE 44. SUMMARY OF TEN BUS ODOR RATINGS
Detroit Diesel 6V-71 E Type Engines

Operating Condition(1)	Odor Quality(2)	Municipal Bus Number										Overall Average
		761	762	763	764	765	766	767	768	769	770	
I	D	5.8	5.1	5.7	6.0	5.6	5.1	5.0	5.4	5.2	4.7	5.4
II	D	5.9	5.4	5.4	5.2	4.8	4.8	4.8	5.2	4.2	4.9	5.1
III	D	5.1	5.0	5.0	5.1	4.6	4.4	5.2	5.5	4.4	4.7	4.9
IV	D	6.2	6.4	5.9	6.7	6.0	5.4	6.3	6.4	5.6	6.2	6.1
V	D	4.8	6.2	5.4	4.5	6.4	4.1	6.6	5.2	5.8	5.4	5.5
I	B	1.7	1.3	1.5	1.8	1.8	1.6	1.6	1.6	1.4	1.3	1.6
II	B	1.8	1.6	1.5	1.6	1.6	1.4	1.5	1.6	1.2	1.5	1.5
III	B	1.5	1.5	1.2	1.4	1.4	1.2	1.7	1.6	1.3	1.2	1.4
IV	B	2.0	1.9	1.9	1.9	2.0	1.7	2.1	2.1	1.7	1.9	1.9
V	B	1.3	1.9	1.4	1.2	2.2	1.1	2.4	1.6	2.0	1.7	1.7
I	O	1.4	1.1	1.1	1.4	1.5	1.2	1.2	1.4	1.2	1.1	1.3
II	O	1.4	1.2	1.2	1.2	1.4	1.1	1.3	1.4	1.1	1.3	1.3
III	O	1.0	1.2	1.0	1.2	1.1	1.0	1.4	1.3	1.0	1.0	1.1
IV	O	1.5	1.6	1.6	1.7	1.6	1.4	1.8	1.8	1.4	1.6	1.6
V	O	1.0	1.6	1.1	1.1	1.6	1.0	1.7	1.3	1.7	1.3	1.3
I	A	0.9	1.0	1.0	1.2	1.2	1.0	1.1	1.0	1.0	1.0	1.0
II	A	1.0	1.0	1.0	0.9	1.1	1.0	0.9	1.1	0.9	1.0	1.0
III	A	0.9	1.0	0.9	1.0	1.0	0.9	1.0	1.1	0.9	0.9	1.0
IV	A	1.0	1.1	1.0	1.1	1.2	1.0	1.2	1.2	1.1	1.3	1.1
V	A	0.9	1.1	0.9	0.9	1.3	0.8	1.3	1.0	1.2	1.2	1.1
I	P	0.8	0.7	0.6	1.0	1.0	0.7	0.7	0.8	0.8	0.8	0.8
II	P	0.9	0.7	0.6	0.8	0.6	0.6	0.7	0.8	0.5	0.7	0.7
III	P	1.0	0.6	0.8	0.7	0.6	0.5	0.7	0.9	0.6	0.7	0.7
IV	P	1.0	1.2	0.9	1.2	1.0	0.7	1.2	1.2	0.8	1.1	1.0
V	P	0.6	1.2	0.4	0.5	1.2	0.4	1.2	0.7	0.9	0.8	0.8

(1) I. Constant speed at 20 mph, 40 hp
II. Constant speed at 40 mph, 40 hp
III. Idle after constant speed operation
IV. Acceleration after 1-min idle
V. Decleration after constant speed.

(2) "D" Diesel composite results
"B" Burnt-smoky results
"O" Oily results
"A" Aromatic results
"P" Pungent results.

TABLE 45. SUMMARY OF TEN BUS ODOR RATINGS
Detroit Diesel 6V-71 E Type Engines

Operating Condition(1)	Odor Quality(2)	Municipal Bus Series										Overall Average
		1	2	3	4	5	6	7	8	9	10	
I	D	7.1	6.6	6.6	6.1	7.2	6.8	7.1	5.8	5.9	7.0	6.6
II	D	7.1	7.2	7.8	6.5	6.3	7.2	6.6	6.8	6.8	8.0	7.0
III	D	7.7	7.1	7.3	6.6	6.4	7.6	7.8	6.8	7.6	7.5	7.2
IV	D	7.3	8.1	8.4	8.5	8.2	7.9	8.4	7.2	7.4	7.7	7.9
V	D	7.8	7.7	7.5	7.3	8.4	8.5	8.9	5.0	7.0	8.2	7.6
I	B	2.5	2.2	2.0	2.2	2.6	2.2	2.5	1.7	1.9	2.2	2.4
II	B	2.3	2.4	2.6	2.2	2.2	2.5	2.3	2.3	2.4	2.8	2.4
III	B	2.6	2.7	2.4	2.2	2.3	2.6	2.7	2.3	2.6	2.6	2.5
IV	B	2.4	3.0	2.9	2.8	2.9	2.8	3.0	2.5	2.4	2.6	2.7
V	B	2.9	2.8	2.5	2.8	2.9	3.0	3.1	1.3	2.2	2.7	2.6
I	O	2.1	1.9	1.9	1.8	2.0	2.2	2.1	1.6	1.8	2.0	1.9
II	O	2.1	2.3	2.4	2.0	1.8	2.4	2.2	2.0	2.2	2.3	2.2
III	O	2.0	1.9	2.0	1.8	1.8	2.2	2.2	2.0	2.4	2.2	2.1
IV	O	2.4	2.6	2.5	2.7	2.6	2.7	2.8	2.0	2.2	2.4	2.5
V	O	2.3	2.3	2.1	2.6	2.6	2.5	2.9	1.3	2.1	2.4	2.3
I	A	1.5	1.3	1.5	1.6	1.6	1.3	1.7	1.2	1.3	1.1	1.4
II	A	1.4	1.8	2.0	1.7	1.3	1.5	1.9	1.5	1.3	1.4	1.6
III	A	1.7	1.9	1.8	1.5	1.7	1.8	2.2	1.7	2.0	1.9	1.8
IV	A	1.7	2.1	2.0	2.1	1.9	1.9	2.0	1.7	1.9	1.7	1.9
V	A	2.1	2.1	1.7	2.2	2.1	2.2	2.3	0.7	1.7	1.4	1.9
I	P	1.1	1.0	1.0	1.0	1.3	1.4	1.6	0.7	0.8	1.2	1.1
II	P	1.2	1.3	1.6	1.1	1.1	1.4	1.2	1.1	1.2	1.6	1.3
III	P	1.5	1.6	1.3	1.6	1.4	2.0	1.8	1.3	1.6	1.3	1.5
IV	P	1.4	1.9	2.0	1.6	1.9	2.6	2.2	1.4	1.4	1.4	1.7
V	P	1.5	1.8	1.5	2.1	2.1	2.1	2.4	0.3	1.5	1.6	1.7

(1) I. Constant speed at 20 mph, 40 hp
II. Constant speed at 40 mph, 40 hp
III. Idle after constant speed operation
IV. Acceleration after 1-min idle
V. Deceleration after constant speed.

(2) "D" Diesel composite results
"B" Burnt-Smoky results
"O" Oily results
"A" Aromatic results
"P" Pungent results.

TABLE 46. COMPARISON EXHAUST ODOR RATINGS FOR TEN E AND TEN N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

Operating Condition(1)	Odor Quality(2)	Max Rating		Min Rating		Range (Max - Min)		Arithmetic Mean		Standard Deviation	
		E Buses	N Buses	E Buses	N Buses	E Buses	N Buses	E Buses	N Buses	E Buses	N Buses
I	D	7.2	6.0	5.8	4.7	1.3	1.3	6.6	5.4	0.49	0.39
II	D	8.0	5.9	6.3	4.2	1.7	1.7	7.0	5.1	0.52	0.45
III	D	7.7	5.5	6.4	4.4	1.3	1.1	7.2	4.9	0.48	0.34
IV	D	8.5	6.7	7.2	5.4	1.3	1.3	7.9	6.1	0.46	0.37
V	D	8.9	6.8	5.0	4.1	3.9	2.7	7.6	5.5	0.33	0.26
I	B	2.6	1.8	1.7	1.3	0.9	0.5	2.4	1.6	0.33	0.18
II	B	2.8	1.8	2.2	1.2	0.6	0.6	2.4	1.5	0.18	0.15
II	B	2.7	1.7	2.2	1.2	0.5	0.5	2.5	1.4	0.17	0.17
IV	B	3.0	2.1	2.4	1.7	0.6	0.4	2.7	1.9	0.23	0.13
V	B	3.1	2.4	1.3	1.1	1.8	1.3	2.6	1.7	0.50	0.42
I	O	2.2	1.5	1.6	1.1	0.6	0.4	1.9	1.3	0.17	0.15
II	O	2.4	1.4	1.8	1.1	0.6	0.3	2.2	1.3	0.19	0.12
III	O	2.4	1.4	1.8	1.0	0.6	0.4	2.1	1.1	0.19	0.14
IV	O	2.8	1.8	2.0	1.4	0.8	0.4	2.5	1.6	0.23	0.13
V	O	2.9	1.7	1.3	1.0	1.6	0.7	2.3	1.3	0.41	0.28
I	A	1.7	1.2	1.1	0.9	0.6	0.3	1.4	1.0	0.19	0.32
II	A	2.0	1.1	1.3	0.9	0.7	0.2	1.6	1.0	0.24	0.22
III	A	2.2	1.1	1.5	0.9	0.7	0.2	1.8	1.0	0.18	0.28
IV	A	2.1	1.3	1.7	1.0	0.4	0.3	1.9	1.1	0.15	0.32
V	A	2.3	1.3	0.7	0.8	1.6	0.5	1.9	1.1	0.47	0.19
I	P	1.6	1.0	0.7	0.7	0.9	0.3	1.1	0.8	0.26	0.12
II	P	1.6	0.9	1.1	0.5	0.5	0.4	1.3	0.7	0.18	0.11
III	P	2.0	1.0	1.3	0.5	0.7	0.5	1.5	0.7	0.22	0.15
IV	P	2.2	1.2	1.4	0.7	0.8	0.5	1.7	1.0	0.29	0.18
V	P	2.4	1.2	0.3	0.4	2.1	0.8	1.7	0.8	0.54	0.31

(1) I. Constant speed at 20 mph, 40 hp
II. Constant speed at 40 mph, 40 hp
III. Idle after constant speed operation
IV. Acceleration after 1-min idle
V. Deceleration after constant speed.

(2) "D" Diesel composite results
"B" Burnt-Smoky results
"O" Oily results
"A" Aromatic results
"P" Pungent results.

Table 46. Comparison of the ranges and standard deviations indicates about the same spread in data under all the operating conditions except the deceleration. Both the range and standard deviation indicate fairly wide variability of the ten E buses compared to the N units. The standard derivation of the N bus data was generally lower overall than that for the E bus group. This means that the preponderance of N bus odor ratings was nearer the mean than for the E buses. Therefore, it is expected that the variability of data from N buses would be less than from E units. The pronounced shift to lower ratings for the N relative to the E powered units is illustrated on Figures 43 through 47. These five bar graphs compare the overall ten-bus arithmetic average for the groups of buses powered by E and N type engines. Figure 43 compares the average "D" rating, the most important indicator of diesel odor, for each of the five operating conditions. Similar comparisons are shown for "B," "O," "A," and "P" on Figures 44 through 47, respectively. In each instance, it may be noted that the group of vehicles powered by the N type engine produced less odor as measured by the four qualities which comprise the overall "D" composite. The "B" burnt quality remained the predominate and most obvious of the four qualities regardless of the type of two-cycle 6V-71 engine. Most noticeable, however, was the reduction in the "B" burnt quality due to the N type engine. Much the same type of trend may be noted for the other three odor qualities.

To confirm that the differences between E and N powered bus exhaust odors were statistically valid, a "U" nonparametric test was performed. The results of this analysis indicated that the differences in odor noted were statistically important. A firm statistical inference may be stated that these differences are not only real but that under practically all conditions, the odor is substantially less. The deceleration condition showed slightly less statistical importance than the other four conditions but was still different.

The results of the variability study at this point confirm the previously determined differences reported in odor output for N engines versus E type, two-cycle 6V-71 engines. A more involved statistical analysis was performed on the N powered bus odor data to determine if there was a statistical difference due to buses and to conditions, and to determine if there was an interaction effect between buses and conditions. It was already known that there is an effect due to different conditions

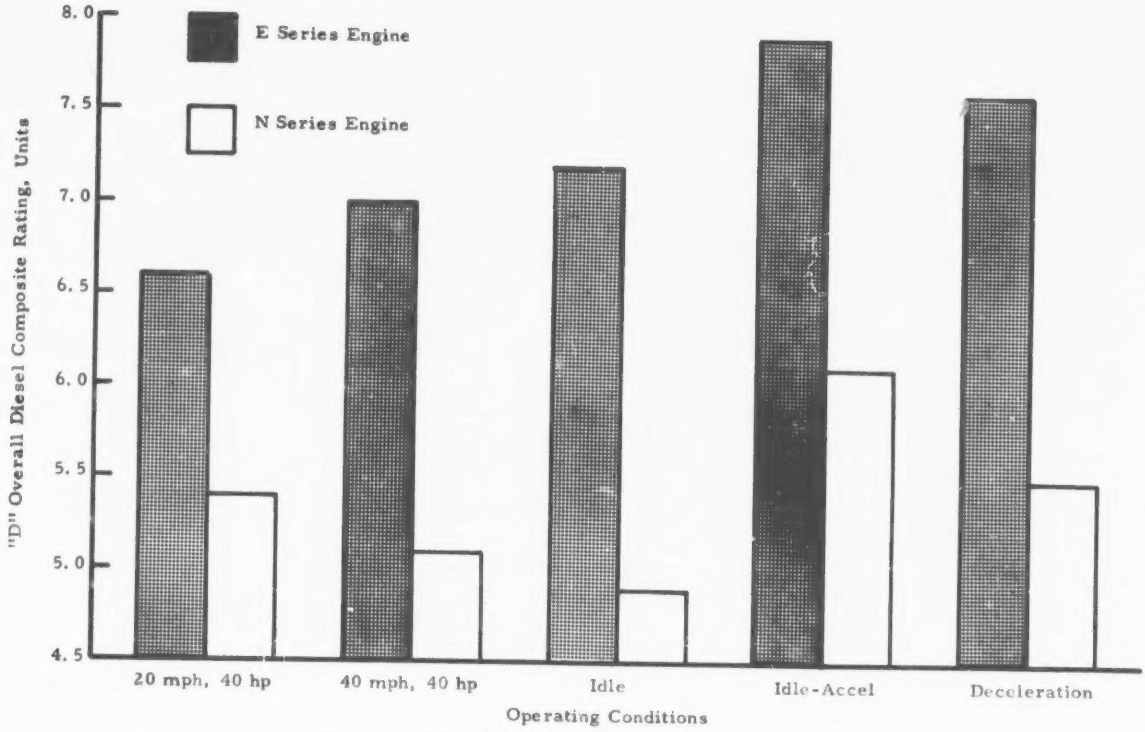


FIGURE 43. COMPARISON OF "D" ODOR RATINGS FROM TEN E AND TEN N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

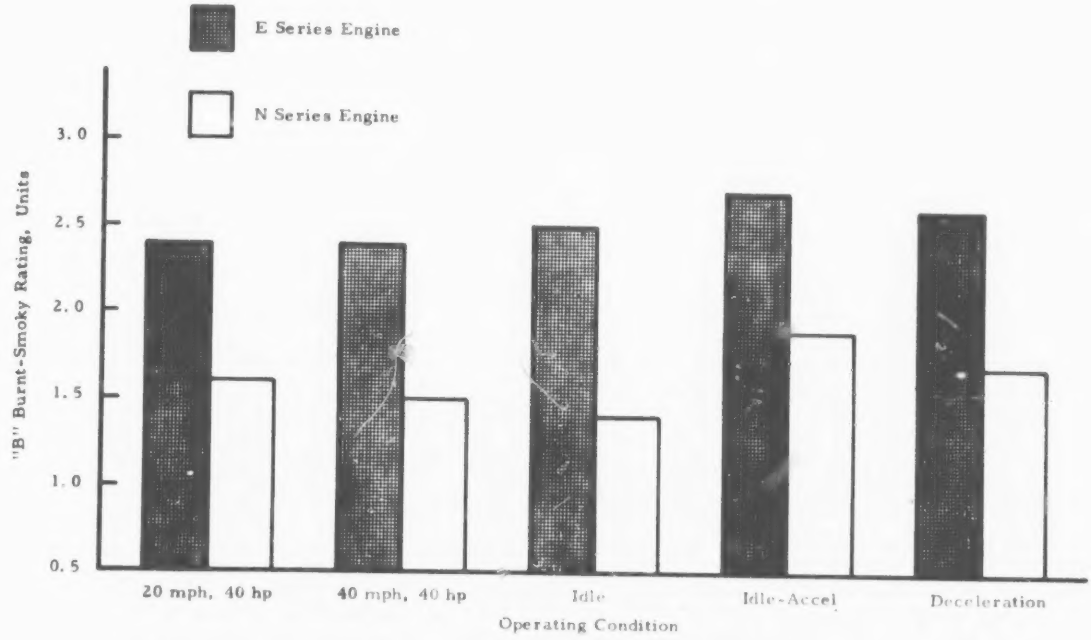


FIGURE 44. COMPARISON OF "B" ODOR RATINGS FROM TEN E AND TEN N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

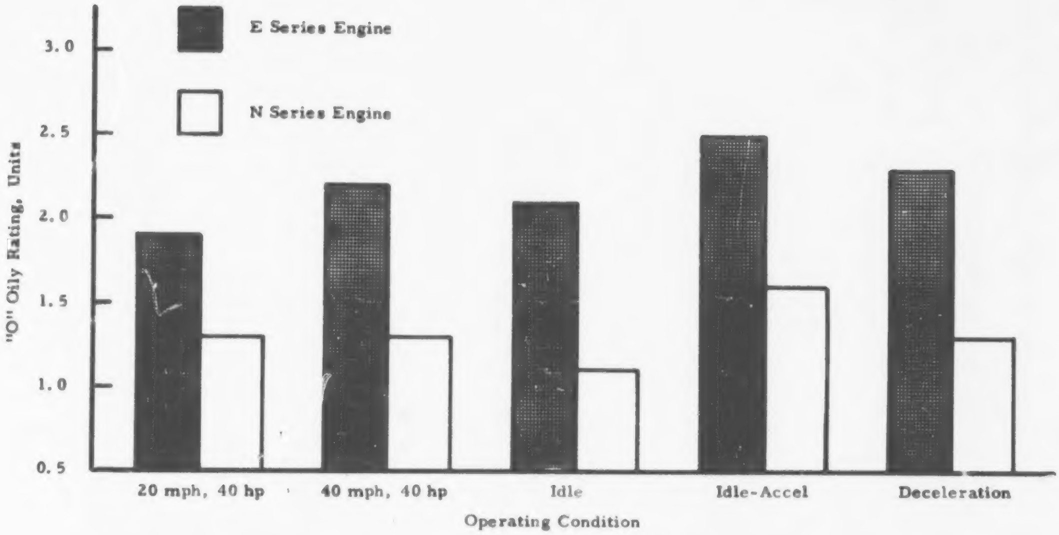


FIGURE 45. COMPARISON OF "O" ODOR RATINGS FROM TEN E AND TEN N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

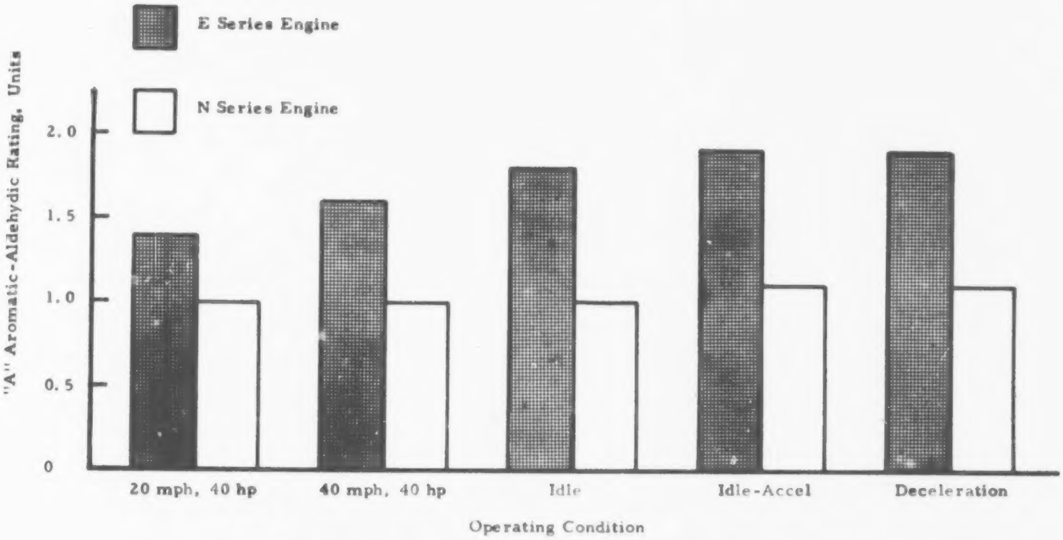


FIGURE 46. COMPARISON OF "A" ODOR RATINGS FROM TEN E AND TEN N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

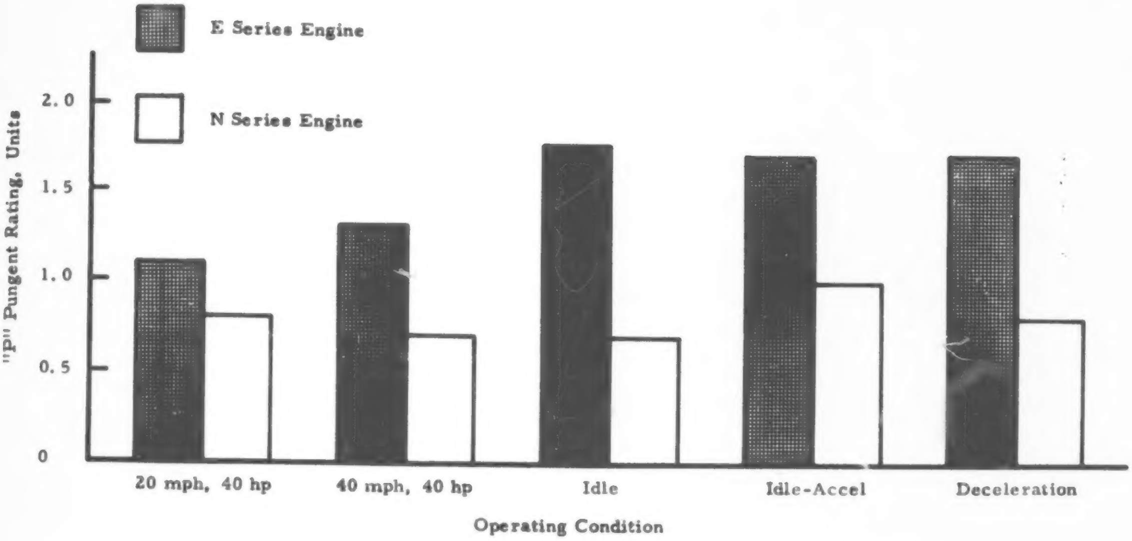


FIGURE 47. COMPARISON OF "O" ODOR RATINGS FROM TEN E AND TEN N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

and, by consideration of the "D" averages and certain of the odor qualities, that there is an effect due to different buses. To confirm these trends and investigate interactions, an analysis or variance for a two-way layout with equal number of observations per cell was selected. The data for this analysis consisted of the "D," "B," "O," "A," and "P" ratings for the ten vehicles and five operating conditions, with four values for each bus at each condition. The experimental plan was a factorial design with two factors and four replicates. Factor 1 (buses) was at ten levels, and factor 2 (conditions) was at five levels.

This method divides the overall scatter of the data into several components consisting of a component for the buses, a component for the operating conditions, a component for the bus-condition interaction, and a component for random or experimental error. By comparing the scatter of each component to the component of error, a statistical test was made to determine the significance of each factor and the interaction. In order to use this method, the variance in each bus-condition cell must be equal. Bartlett's test was used to test the hypothesis of equal variance for the five variables ("D," "B," "O," "A," and "P"). Since the hypothesis of equal variance could not be rejected, an analysis of variance could be performed.

The ratio used is known as the "F" statistic, the ratio of the estimated variance due to the factor divided by the estimated error variance. The null hypothesis is that there is no difference due to the factor (buses, for example) according to the following model:

$$Yij = u + b_i + eij$$

where

Y - variable under consideration such as "D," "B," "O," "A," and "P"

u - general mean of the population of the "D" reading for example

b - effect due to the individual buses

e - error (normally distributed error assumed)

i - particular bus

j - particular reading for the i th bus

For these analyses, the CDC 6600 computer was used. The "F" statistics obtained are tabulated below.

Factor	"D"	"B"	"O"	"A"	"P"
Buses	6.3	7.7	8.1	2.7	5.6
Conditions	36.0	35.5	44.0	8.3	19.2
Interaction	4.1	3.8	3.5	1.8	2.6

A significance level of 0.01 was selected as the criteria for determining whether the "F" statistic was significant. A significance level of 0.01 means that the null hypothesis will be rejected when it is actually true one time in a hundred or having a probability of 0.01. Selection of 0.01 is the strictest test usually employed for this type of data.

For the significance level of 0.01, the significant "F" statistics are any values over 2.5 for buses, 3.4 for conditions, and 1.7 for interactions. On this basis, it may be noted that all "F" statistics are significant and that there definitely was a difference due to buses and a difference due to conditions. Also, this analysis indicates an interaction effect between buses and conditions. Although the effect due to different conditions and different buses was already suspected from a look at the average "D" responses, the interaction effect was somewhat surprising. Reviewing the data on Table 44, there appears to be some interaction effect between the buses and constant speed and deceleration conditions. Figure 48 is a plot of one of the constant speed conditions, the 20-mph, 40-hp cruise, and the deceleration "D" values for each of the ten E and N powered buses. The upper set of curves for the E buses shows for the most part that when the "D" rating increased or decreased during the 20-mph cruise, the deceleration rating also increased or decreased. From a plot of the

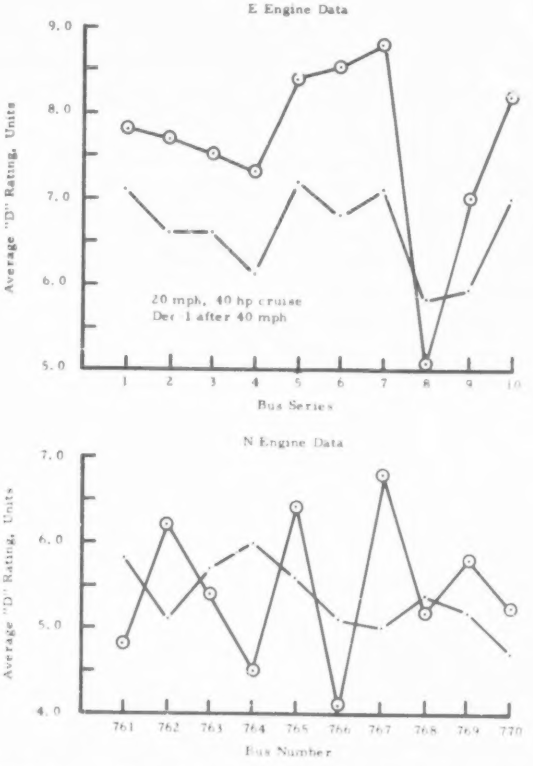


FIGURE 48. INTERACTION EFFECT (ODOR) BETWEEN THE 20-MPH, 40-HP CRUISE AND DECEL CONDITIONS FOR BUSES POWERED BY E AND N TYPE ENGINES

same two conditions for the E powered group of ten buses, such a generally predictable interaction effect is not apparent.

The N type fuel injector minimizes the dribble problems encountered with the S type injectors typically used in the older E type engines. Thus, the strange, sour, penetrating odor easily detected from some E type buses during closed throttle-deceleration conditions, both on the road and in the laboratory, was abated. The reasons for the N powered bus interaction effect are not certain at this time. For complete odor test results, please refer to Appendix C, Tables 3 to 12.

D. Smoke Results

Summarized on Table 47 are the smoke baseline data for the ten N powered municipal buses, with maximum, minimum, and average smoke output obtained under constant speed and transient type conditions listed. Smoke results for the ten E buses, from the Part I final report (Reference 1) are reproduced as Table 48 and are compared with the N smoke data on Table 49. The range of smoke obtained from the N buses was about one-third or less than that with the E's under all conditions. Considering the average E and N data, along with the range comparison, it is apparent that the overall

TABLE 47. SUMMARY OF TEN BUS SMOKE RATINGS
Detroit Diesel 6V-71 N Type Engines

Type of Operation(1)	Vehicle Speed, mph	Municipal Bus Number 761	762	763	764	765	766	767	768	769	770	Overall Average
Constant Speed	20	5.7	6.3	5.7	5.3	9.0	3.0	4.0	5.7	5.0	5.7	5.5
Constant Speed	25	4.0	3.8	3.3	3.3	6.0	2.0	3.0	4.0	3.7	3.3	3.6
Constant Speed	30	3.3	3.5	3.3	3.0	4.7	2.0	2.0	3.0	2.7	2.3	3.0
Constant Speed	35	2.8	3.2	2.7	3.0	3.3	2.0	2.0	3.0	2.0	2.3	2.6
Idle-Accel (40 hp at 30 mph)	Start	3.7	2.0	4.0	4.0	6.0	2.0	7.7	4.7	3.0	8.0	4.5
	Accel	1.7	3.0	2.0	3.3	3.7	1.0	2.0	2.0	1.7	3.0	2.3
	Upshift	2.3	4.0	3.7	3.7	4.7	1.7	2.0	3.7	3.0	2.7	3.2

(1)All constant speed smoke measurements made at maximum power output in drive range.
All idle-acceleration smoke measurements made at open rack with full inertia simulation.

TABLE 48. SUMMARY OF TEN BUS SMOKE RATINGS
Detroit Diesel 6V-71 E Type Engines

Type of Operation	Vehicle Speed, mph	Municipal Bus Series 1	2	3	4	5	6	7	8	9	10	Overall Average
Constant Speed	20	16.8	14.0	23.3	19.0	19.1	8.8	14.5	20.0	20.6	15.5	17.2
Constant Speed	25	14.9	11.3	20.1	17.6	13.3	6.3	9.3	16.1	15.4	13.5	13.8
Constant Speed	30	14.3	11.4	19.8	16.5	14.4	6.6	6.9	14.4	13.3	14.5	13.2
Constant Speed	35	12.0	9.8	12.4	12.1	12.1	5.1	6.0	11.8	10.9	10.5	10.3
Idle-Accel (40 hp at 30 mph)	Start	23.5	15.6	18.3	26.3	16.8	26.8	19.8	31.5	29.3	33.0	24.1
	Accel	12.9	6.9	8.6	9.3	6.9	2.5	4.1	7.9	8.0	11.0	7.8
	Upshift	13.3	11.8	19.0	17.6	12.1	5.0	7.5	14.0	14.6	13.0	12.8

(1) All constant speed smoke measurements made at maximum power output in drive range.
All idle-acceleration smoke measurements made at open rack with full inertia simulation.

TABLE 49. COMPARISON OF EXHAUST SMOKE RATINGS FOR TEN E AND N DETROIT DIESEL 6V-71 POWERED MUNICIPAL BUSES

Type of Operation(1)	Vehicle Speed, mph	Max Rating		Min Rating		Range (Max - Min)		Arithmetic Mean		Standard Deviation	
		E Buses	N Buses	E Buses	N Buses	E Buses	N Buses	E Buses	N Buses	E Buses	N Buses
Constant Speed	20	23.3	9.0	8.8	4.0	14.5	5.0	17.2	5.5	3.93	0.47
Constant Speed	25	20.1	6.0	6.3	2.0	13.8	4.0	13.8	3.6	3.82	0.30
Constant Speed	30	19.8	4.7	6.6	2.0	13.2	2.7	13.2	3.0	3.84	0.24
Constant Speed	35	12.4	3.3	5.1	2.0	7.3	1.3	10.3	2.6	2.50	0.49
Idle-Accel (40 hp at 30 mph)	Start	33.0	8.0	16.3	2.0	16.7	6.0	22.5	4.5	5.35	0.21
	Accel	11.0	3.7	3.0	1.0	8.0	2.7	8.0	2.3	2.88	0.26
	Upshift	19.8	4.7	5.3	1.7	14.5	3.0	13.0	3.2	3.90	0.29

(1)All constant speed smoke measurements made at maximum power output in drive range.
All idle-acceleration smoke measurements made at open rack with full inertia simulation.

reduction in average smoke output for the N's was accompanied by a reduction in variability of the data of the same magnitude. This is further shown by the significant reduction in standard deviation values for the N versus the E buses.

Further consideration of the smoke data on Table 47 indicates that an analysis of variance was not appropriate. In many of the cells, the data were a constant, which means that the data obtained in triplicate repeated identically. The data were ranked, however, from high to low on the basis of average smoke reading for each operating condition and are shown on Table 50. Bus 765 ranked high in all cases except during engine start, and Bus 766 ranked low in all cases. The engine start condition is a momentary, one black puff transient which, under normal routine operation, does not occur very often during the day and thereby has least importance of those conditions reported.

Figure 49 is a plot of the E and N smoke data for two conditions by bus number. The two conditions plotted are the 20-mph maximum power drive range condition and the maximum average reading obtained during the upshift from low to drive range. There was a difference in smoke emissions due to buses and a difference due to condition. As far as the physical significance of the smoke values, values less than 10-percent opacity are generally adjudged to be light. Therefore, most, if not all, of the smoke evaluated from all ten N powered buses can be judged as either light or very light in smoke level. For detailed smoke data, please see Tables 13 to 23 of Appendix C.

TABLE 50. RANKING OF TEN N POWERED MUNICIPAL BUSES BY AVERAGE SMOKE OUTPUT; HIGH TO LOW

A (20 mph)		B (25 mph)		C (30 mph)		D (35 mph)		E (Start)		F (Accel)		G (Upshift)	
Bus No.	Avg*	Bus No.	Avg	Bus No.	Avg	Bus No.	Avg	Bus No.	Avg	Bus No.	Avg	Bus No.	Avg
765	9.0	765	6.0	765	4.7	765	3.3	770	8.0	765	3.7	765	4.7
762	6.3	761	4.0	762	3.5	762	3.2	767	7.7	764	3.3	762	4.0
761	5.7†	768	4.0	761	3.3	764	3.0	765	6.0	762	3.0	763	3.7
763	5.7	762	3.8	763	3.3	768	3.0	768	4.7	770	3.0	764	3.7
768	5.7	769	3.7	764	3.0	761	2.8	763	4.0	763	2.0	768	3.7
770	5.7	763	3.3	768	3.0	763	2.7	764	4.0	767	2.0	769	3.0
764	5.3	764	3.3	769	2.7	770	2.3	761	3.7	768	2.0	770	2.7
769	5.0	770	3.3	770	2.3	766	2.0	769	3.0	761	1.7	761	2.3
767	4.0	767	3.0	766	2.0	767	2.0	762	2.0	769	1.7	767	2.0
766	3.0	766	2.0	767	2.0	769	2.0	766	2.0	766	1.0	766	1.7

---

*Percent opacity per PHS smokemeter.
†] denotes tie.

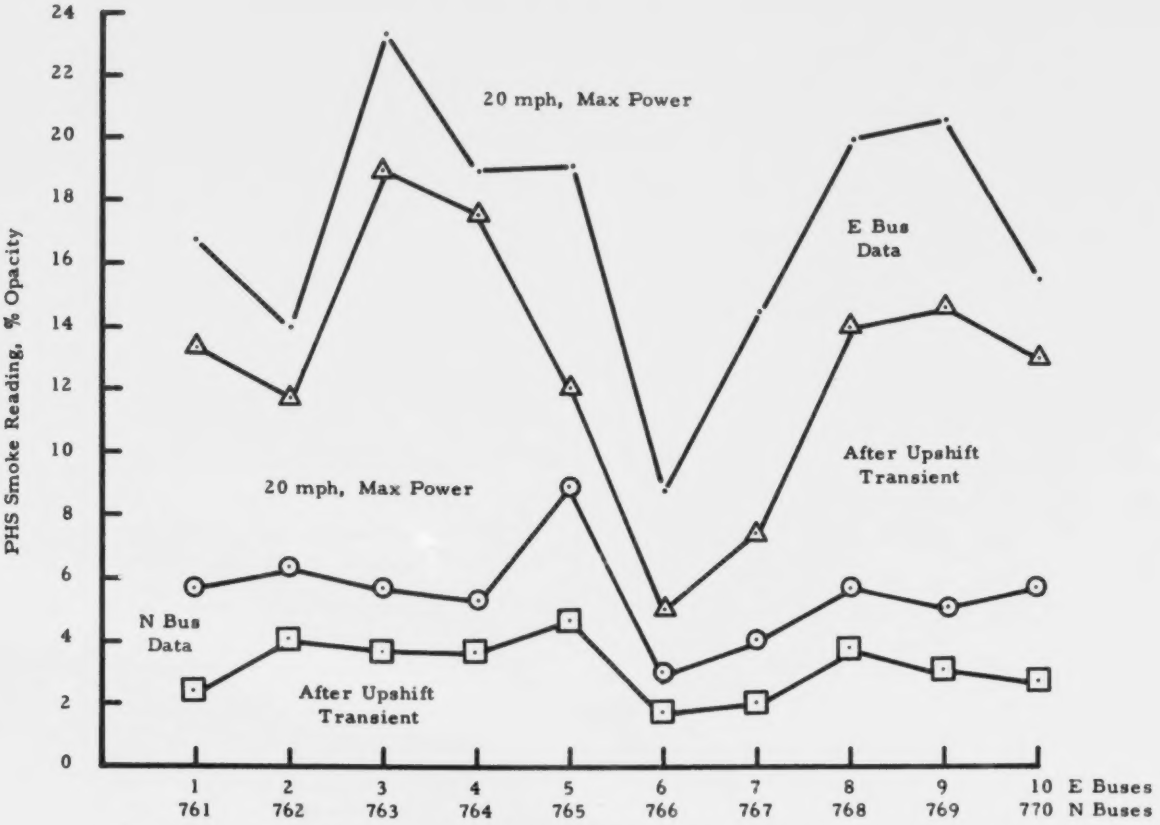


FIGURE 49. LACK OF INTERACTION EFFECT (SMOKE) BETWEEN THE 20-MPH MAX POWER AND "AFTER UPSHIFT" DATA FOR BUSES POWERED BY E AND N TYPE ENGINES

E. Summary

In summary, smoke and odor emissions from a group of ten municipal buses powered by N type Detroit Diesel 6V-71 engines are less than those from a similar group of buses powered by the E type 6V-71 engine. These differences were consistent and have statistical importance. In the case of odor, differences of 1 to 2 "D" unit intensities were common overall. Smoke emissions were found to be about one-third or less than those found with the E type engine under identical operating conditions. An analysis of variance of the odor data confirms the suspected difference in odor due to buses, conditions, and also revealed an interaction effect between N powered buses and conditions.

VI. EMISSIONS FROM A VARIETY OF DIESEL TRUCKS

The objective of this phase is to obtain odor, smoke, and other emissions data with a variety of trucks powered by both naturally aspirated and turbocharged diesel engines. A variety of engine-driveline configurations were studied requiring modification to the current procedures developed for a Cummins NH-220 powered tandem drive axle (tractor equipped with a 10-speed transmission).

The tractors evaluated are listed below:

Tractor	Engine	Driveline
1967 Ford	Cummins NH-250 derated to 225 hp at 2100 rpm	10-speed transmission with tandem drive, single-speed rear axles
1964 GMC	Detroit Diesel 6-71 N	10-speed transmission with tandem drive, single-speed rear axles
1961 Mack	Mack ENDT 673	Triplex 5-speed transfer case 3-speed single drive axle
1969 IHC	Detroit Diesel 8V-71 N	10-speed transmission with tandem drive, single speed axles
1968 Ford	Cummins NH-250 derated to 225 hp at 2100 rpm	10-speed transmission with single speed, single drive axle
1965 White Freightliner	Cummins NH-220	10-speed transmission with single speed, single drive axle and drag axle

The approach was to modify the odor and smoke procedures developed during the Part I project to permit laboratory evaluation of vehicles with different types of engines, transmission and rear axle combinations. Availability of turbocharged rental vehicles limited operation with this type of engine. Odor procedures were modified to operate the engine under near maximum power within the recommended operating speed range and accel-decel conditions were modified to obtain panel evaluation at comparable conditions.

A. Emissions from 1967 Ford

The first vehicle studied was a 1967 Ford tractor powered by a Cummins NH-250 derated to 225 hp at 2100 rpm engine. This engine, popularly used in intercity trucking, is naturally aspirated and has an in-line six-cylinder open type combustion chamber. The rear axle and transmission were Eaton tandem single-speed and 10-speed Fuller Road Ranger, respectively.

Table 51 summarizes the odor and smoke results by listing the overall average "D" diesel, "B" burnt, "O" oily, "A" aromatic, and "P" pungent odor results, at 700:1 dilution level (realistic for vertical stack equipped tractor-trailers). The odor ratings, less than 3.0 for the "D" diesel composite rating, compare satisfactorily to odor ratings obtained with the similar NH-220 under essentially identical operating conditions. The "B," "O," and "P" ratings were all less than 1.0, and the "P" rating was almost negligible. The smoke results indicate that this engine produced less than 15-percent opacity under all conditions investigated.

In Table 52, the emissions other than odor and smoke are tabulated for each of the four operating conditions. Like odor, these values represent quadruplicate determinations obtained simultaneously with odor. Both hydrocarbons and CO appear to be fairly low at all speeds and loads, less than 80 ppm C and 1580 ppm (as-measured).

For a complete description of this tractor, the adjusted procedures developed for evaluation and detailed odor and smoke results, please refer to Tables 1 to 13 of Appendix D.

TABLE 51. ODOR AND SMOKE SUMMARY

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Engine: Cummins NH-250
Fuel: EM-29-F (No. 2 Diesel)

Odor Summary, Q/I Average
(700:1 Dilution)

Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
23-mph cruise, 150 hp at 1500 rpm	2.6	0.8	0.7	0.7	0.2
27-mph cruise, 150 hp at 1800 rpm	2.2	0.7	0.6	0.6	0.1
32-mph cruise, 150 hp at 2100 rpm	2.2	0.7	0.7	0.7	0.1
Idle after cruise	3.0	0.9	0.8	0.8	0.2
Acceleration after idle	2.5	0.9	0.8	0.5	0.2
Acceleration in 8th gear	2.3	0.9	0.7	0.5	0.1
Deceleration after cruise	3.1	1.0	0.7	0.7	0.1

Smoke Summary, PHS Average

Constant Speed			Acceleration	
Engine Speed, rpm	Vehicle Power, hp	PHS Smoke, Percent Opacity	Transmission Gear No.	PHS Smoke, Percent Opacity
1500	142	11	5	8
1700	158	11	6	10
1900	166	11	7	9
2100	174	13	8	11
2200	116	6	9	13
			10	15

TABLE 52. EXHAUST EMISSIONS SUMMARY

(As-Measured)

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Engine: Cummins NH-250
Fuel: EM-29-F (No. 2 Diesel)

	Operating Conditions			
Constituent	Idle	150 hp at 1500 rpm	150 hp at 1800 rpm	150 hp at 2100 rpm
Hydrocarbons, ppm C	110	75	73	80
CO, ppm	65	1580	986	1064
NO, ppm	223	1059	969	969
Total Aldehydes, ppm	28.1	23.7	22.1	23.3
Formaldehyde, ppm	2.1	3.3	2.0	2.8
Acrolein, ppm	0.9	1.2	1.2	1.1
CO_2, percent	0.6	6.4	6.7	7.4

B. Emissions from 1964 GMC

The GMC tractor, powered by a six-cylinder, inline, four-valve, Detroit Diesel 6-71 N series engine equipped with 60N injectors was the same vehicle used in the Part II study of engine derating. At that time, only odor and smoke measurements were obtained (refer to Part II, Final Report, Reference 3, for details). For additional descriptive data of the tractor, engine and driveline, please refer to Table 14 of Appendix D. Described on Tables 15 through 23 are the operating conditions and procedures for obtaining odor and smoke baseline data. These conditions are very similar to those used for the Cummins NH-220 and NH-250 powered tandem drive axle, ten-speed transmission tractors previously investigated.

Summarized on Table 53 are the results of the odor and smoke measurements obtained with the two-cycle powered tractor. Seven odor conditions are listed: four steady-state conditions followed by three transients. "D" ratings ranged from 3.1 to 3.8, and the "B" ratings were generally 1.0. The dilution level employed was 700:1. Shown on the bottom portion of Table 53 are the smoke results of both the constant speed and the acceleration smoke levels as measured with the PHS full-flow light-extinction smokemeter. Under constant speed, maximum power conditions, the smoke levels ranged from about 15.5 percent at 1500 rpm to 3.5 percent at 2100 rpm. During acceleration, the average peak smoke levels ranged from 12 to 17 percent. Listed on Table 54 are the average as-measured exhaust emissions other than smoke and odor. A complete listing of the odor, smoke, and other exhaust emissions may be found on Tables 24 to 26 of Appendix D.

TABLE 53. ODOR AND SMOKE SUMMARY

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Fuel: EM-29-F (No. 2 Diesel)

Odor Summary, Q/I Average
(700:1 Dilution)

Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
25-mph cruise, 140 hp at 1500 rpm	3.1	1.0	0.9	0.8	0.2
28-mph cruise, 150 hp at 1800 rpm	3.8	1.0	0.9	0.9	0.4
32-mph cruise, 140 hp at 2100 rpm	3.4	1.0	0.9	0.8	0.2
Idle after cruise	3.4	1.0	0.9	0.9	0.2
Acceleration after idle	3.3	1.0	1.0	0.8	0.4
Acceleration in 8th gear	3.6	1.1	1.0	0.9	0.5
Deceleration after cruise	3.1	1.0	1.0	0.9	0.3

Smoke Summary, PHS Average

Constant Speed			Acceleration	
Engine Speed, rpm	Vehicle Power, hp	PHS Smoke, Percent Opacity	Transmission Gear No.	PHS Smoke, Percent Opacity
1500	145	15.5	5	12
1700	145	14.0	6	13
1900	160	11.5	7	16
2100	180	3.5	8	15
2200	--	--	9	14
			10	17

TABLE 54. EXHAUST EMISSIONS SUMMARY

(As-Measured)

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Fuel: EM-29-F (No. 2 Diesel)

	Operating Conditions			
Constituent	Idle	140 hp at 1500 rpm	150 hp at 1800 rpm	140 hp at 2100 rpm
Hydrocarbons, ppm C	385	1024	705	465
CO, ppm	156	1141	1010	391
NO, ppm	273	1638	1593	1488
Total Aldehydes, ppm	20	17	22	16
Formaldehyde, ppm	8	7	8	6
Acrolein, ppm	3	2	4	2
CO_2, percent	0.6	5.5	5.8	5.1

C. Emissions from 1961 Mack

The Mack single-axle, cabover tractor powered by a Mack ENDT 673C, 250-hp, 672-cu-in. displacement, four-cycle, six-cylinder, turbocharged engine is described in detail on Table 27 of Appendix D. This vehicle, equipped with the Mack Triplex system of 15 forward speeds (five speeds in the transfer case and three speeds in the axle), required a number of revisions to the operating conditions and procedures. These revised methods are described on Tables 28 through 36 of Appendix D. The largest departure from the normal methods used to date was the operation with 25,000-lb vehicle weight inertia simulation on a single-drive axle instead of the usual 32,000 lb, 16,000 lb per axle, normally used with tandem drive units. Accordingly, the vehicle was operated with 7000 lb less inertia simulation and resulted in slightly faster accelerations, particularly at low speed. At operating speeds of about 20 mph and above, the effect of road load power absorption (the water brake dynamometer follows the "q" curve characteristic of increasing load with an increase in speed) still made it possible to operate the vehicle under realistic road-like conditions. Slightly higher vehicle speeds were required in order to absorb the full vehicle power output from one drive axle. During the smoke operating conditions, the maximum speed investigated was 70 mph in 14th gear at 2200-rpm engine speed. No difficulties were involved in adapting the procedures for this fairly powerful single-axle tractor. As with the previous tractors evaluated, typical number 2 diesel fuel and 700:1 exhaust dilution level were employed.

Two views of the Mack tractor under test on the SwRI chassis dynamometer are shown in Figures 50 and 51. Figure 50, the front view, shows the PHS smokemeter readout box and dual-pen strip chart recorder to the left of the vehicle. The rear view, Figure 51, shows the PHS smokemeter installed on the 4-in.-diameter vertical stack.

Table 55 summarizes the odor and smoke baseline data acquired with the Mack ENDT 673C engine. The "D" ratings varied from 2.5 to 3.2, and the "B" ratings averaged about 0.8. Shown on the bottom of Table 55 are the average smoke readings obtained at 1100 through 2200 rpm under maximum power output along with acceleration smoke readings in gears 7 through 13. Under the constant speed conditions, the smoke opacity ranged from 33.5 percent at 1100 rpm to 6 percent at 2200 rpm. The normal operating range of this engine is considered to be 1500 to 2100 rpm within which the smoke varied from 16.5- to 6.5-percent opacity. During the transient acceleration through gears 7 to 13, the average peak smoke output varied from 32 to 35 percent. By presetting 40 hp in the water brake dynamometer at 30 mph, the "q" load characteristic of the water brake did not permit acceleration beyond 13th gear.

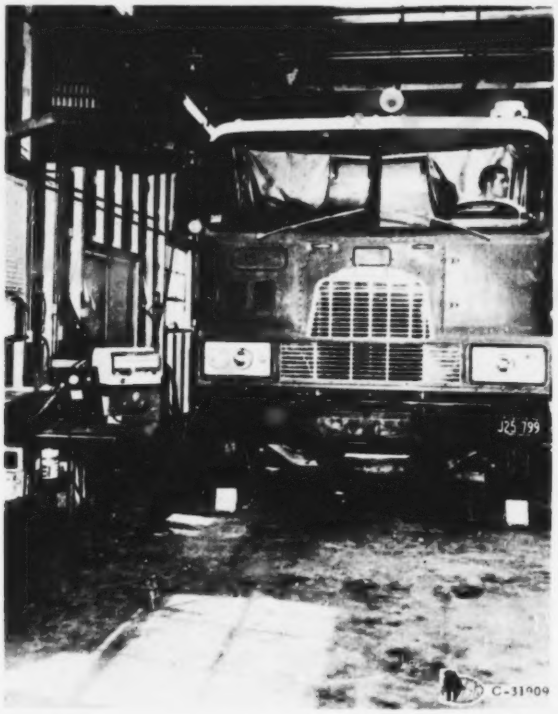


FIGURE 50. SINGLE-AXLE TRUCK-TRACTOR PREPARED FOR TEST
Front View

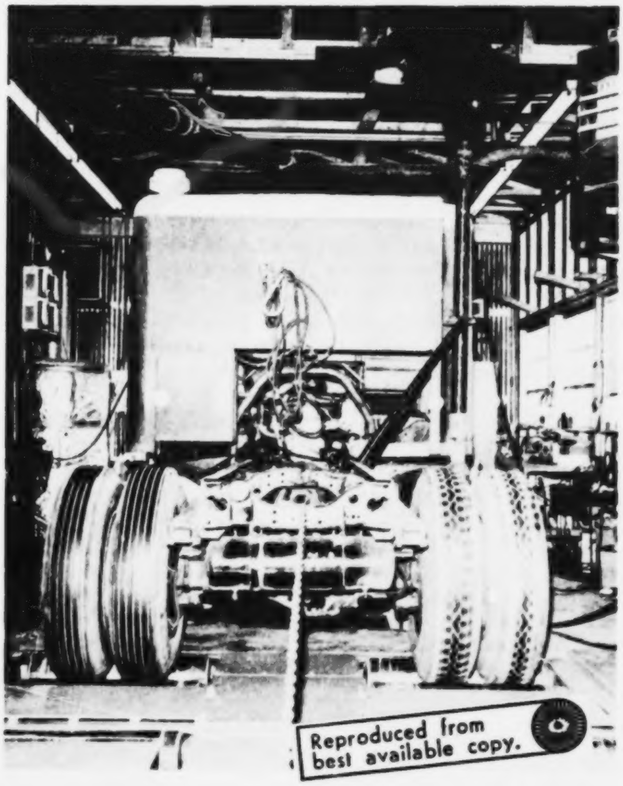

Reproduced from best available copy.

FIGURE 51. SINGLE-AXLE TRUCK-TRACTOR UNDER DYNAMOMETER TEST
Rear View

TABLE 55. ODOR AND SMOKE SUMMARY

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT 673C
Fuel: EM-29-F (No. 2 Diesel)

Odor Summary, Q/I Average
(700:1 Dilution)

Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
35-mph cruise, 140 hp at 1500 rpm	2.8	0.7	0.9	0.8	0.5
41-mph cruise, 140 hp at 1800 rpm	3.0	0.8	1.0	0.9	0.4
48-mph cruise, 140 hp at 2100 rpm	3.2	0.8	0.9	0.9	0.6
Idle after cruise	3.0	0.9	0.9	0.9	0.3
Acceleration after idle	2.9	0.8	0.9	0.8	0.4
Acceleration in 12th gear	2.5	0.7	0.9	0.6	0.2
Deceleration after cruise	2.9	0.8	1.0	0.8	0.2

Smoke Summary, PHS Average

Constant Speed			Acceleration	
Engine Speed, rpm	Vehicle Power, hp	PHS Smoke, Percent Opacity	Transmission Gear No.	PHS Smoke, Percent Opacity
1100	103	33.5		
1300	125	25.0		
1500	155	16.5	7	35
1700	160	14.0	8	33
1900	173	10.0	10	33
2100	184	6.5	11	35
2200	160	6.0	12	32
			13	35

On Table 56 are the chemical constituent concentrations on an as-measured basis. The effect of speed on emissions, all at essentially the same power level, indicated that at 1500 rpm, the minimum recommended operating speed, the HC was lowest and CO was highest. For complete data on procedural changes, smoke, odor, and emissions, please see Tables 28 through 39 of Appendix D.

D. Emissions from 1969 International Harvester

This new cabover International Harvester tractor, with 12,357 miles, was powered by a Detroit Diesel 8V-71 N, a four-valve engine equipped with 60N injectors. The driveline consisted of a Fuller ten-speed transmission with tandem drive, single speed rear axles. As the running gear was essentially the same as that of tractors already tested, modifications to the procedures involved adjustments for the higher horsepower output of this eight-cylinder engine (280 hp at 2100 rpm). For odor measurements, the 700:1 dilution ratio was used and EM-90-F, a known No. 2 diesel fuel, was used. This tractor was equipped with dual 4-in. diameter exhaust stacks, one for each bank of the V-8 engine. Odor and smoke tests were made with the exhaust from the right bank and the exhaust from the left bank was ducted out away from the test area. Visual observation indicated that the smoke from both banks of the engine was essentially the same, justifying the use of one bank.

Shown in Table 57 are the average odor panel responses for the seven truck conditions. The ratings were on the order of a "D"-2 or less with the "B" rating being the most obvious of the four

TABLE 56. EXHAUST EMISSIONS SUMMARY

(As-Measured)

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT 673C
Fuel: EM-29-F (No. 2 Diesel)

Constituent	Operating Conditions Idle	140 hp at 1500 rpm	140 hp at 1800 rpm	140 hp at 2100 rpm
Hydrocarbons, ppm C	325	244	302	293
CO, ppm	310	258	878	775
NO_x, ppm NO_2	598	1484	1308	976
NO, ppm	620	1625	1298	1045
Total Aldehydes, ppm	26	35	24	31
Formaldehyde, ppm	14	18	18	15
Acrolein, ppm	13	18	15	14
CO_2, percent	0.9	10.4	8.7	7.6

TABLE 57. ODOR AND SMOKE SUMMARY

Vehicle: 1969 IHC
Date: June 25, 1969

Engine: Detroit Diesel 8V-71 N
Fuel: EM-90-F (No. 2 Diesel)

Odor Summary, Q/I Average
(700:1 Dilution)

Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
26-mph cruise, 160 hp at 1500 rpm	2.0	0.8	0.4	0.4	0.1
31-mph cruise, 170 hp at 1800 rpm	1.3	0.6	0.3	0.5	0
36-mph cruise, 180 hp at 2100 rpm	1.4	0.6	0.3	0.4	0
Idle after cruise	1.8	0.7	0.4	0.7	0.2
Acceleration after idle	1.8	0.8	0.6	0.5	0.1
Acceleration	2.1	0.9	0.6	0.3	0.1
Deceleration after cruise	1.5	0.8	0.3	0.3	0

Smoke Summary, PHS Average

Constant Speed Engine Speed, rpm	Vehicle Power, hp	PHS Smoke, Percent Opacity
1500	160	3.7
1700	170	3.2
1900	180	2.8
2100	190	3.3
2200	200	3.3

Acceleration Transmission Gear No.	PHS Smoke, Percent Opacity
5	3.3
6	3.0
7	3.0
8	2.8
9	2.4
10	3.5

quality standards. This is similar to other scavenged two-cycle engines evaluated. Also shown on Table 57 are the results of the constant speed and acceleration smoke tests. The readings were all less than 5 percent, a very light smoke level. Other exhaust emissions are summarized on Table 58 for each of the four constant speed odor conditions. Hydrocarbons were on the order of 200 ppm; CO under one condition was over twice that of the other two constant speed conditions. For a complete description of the vehicle operating procedures, smoke, odor, and other exhaust emissions, please refer to Tables 40 through 50 of Appendix D.

TABLE 58. EXHAUST EMISSIONS SUMMARY

(As-Measured)

Vehicle: 1969 IHC
Date: June 25, 1969

Engine: Detroit Diesel 8V-71N
Fuel: EM-90-F (No. 2 Diesel)

	Operating Conditions			
Constituent	Idle	160 hp at 1500 rpm	170 hp at 1800 rpm	180 hp at 2100 rpm
Hydrocarbons, ppm C	193	195	208	237
CO, ppm	154	2120	802	828
NO_x, ppm NO_2	283	1250	1149	993
NO, ppm	370	1230	1305	1125
NO_2, ppm	33	54	51	49
Total Aldehydes, ppm	18	18	18	16
Formaldehyde, ppm	5	7	6	7
Acrolein, ppm	2	3	2	2
CO_2, percent	0.9	6.9	6.8	6.6

E. Emissions from 1968 Ford

Another Cummins NH-250 was evaluated in a single-drive axle 1968 Ford chassis. The vehicle was equipped with a ten-speed Fuller Road Ranger transmission similar to other vehicles evaluated. The engine was custom derated to 225 hp at 2100 rpm. Modifications to the operating procedures were similar to that required for the 1961 Mack single-axle tractor in that 25,000 lb of inertia simulation was used on the single-drive axle. Front and rear views of this tractor mounted on the chassis dynamometer and prepared for odor and smoke evaluations are shown in Figures 8 and 9. Otherwise, the usual 700:1 dilution level for odor measurement and No. 2 diesel fuel was employed.

Table 59 contains a summary of odor and smoke data. Odor ratings were around "D"-2 or less except for the deceleration after cruise which was an average "D"-3. The "O," "A," and "B" ratings were all in the neighborhood of 0.6 to 1.0. For this derated tractor, the smoke output was a maximum of 11-percent opacity at 2100 rpm. As in other naturally aspirated engines of this type, the acceleration smoke output was very similar to that obtained under constant speed conditions. Table 60 contains the as-measured exhaust emissions. Relative to the other two constant speed conditions, the CO at 1500 rpm was higher, 2200 ppm versus about 700 ppm. For additional details regarding this tractor, please refer to Appendix D Tables 51 through 61.

F. Emissions from 1965 White Freightliner

The last vehicle in this series of tests was a 1965 White Freightliner powered by a Cummins NH-220 diesel engine. The transmission was a ten-speed Fuller Road Ranger. Although the vehicle was equipped with a tandem axle, only the front axle transmitted power to the road with the back axle, known as a dead or drag axle, capable of carrying load only. This arrangement was handled like other single-drive axle units and 25,000-lb inertia simulation employed.

TABLE 59. ODOR AND SMOKE SUMMARY

Vehicle: 1968 Ford Tractor	Engine: Cummins NH-250
Date: July 22, 1969	Fuel: EM-90-F (No. 2 Diesel)

Odor Summary, Q/I Average
(700:1 Dilution)

Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
39-mph cruise, 150 hp at 1500 rpm	2.0	0.8	0.8	0.6	0
38-mph cruise, 150 hp at 1800 rpm	1.9	0.8	0.8	0.7	0.1
35-mph cruise, 150 hp at 2100 rpm	1.7	0.8	0.7	0.6	0
Idle after cruise	2.1	0.8	0.9	0.6	0.1
Acceleration after idle	1.8	0.8	0.7	0.8	0.2
Acceleration	1.6	0.7	0.7	0.7	0.1
Deceleration after cruise	3.0	1.0	1.1	0.9	0.4

Smoke Summary, PHS Average

Constant Speed			Acceleration	
Engine Speed, rpm	Vehicle Power, hp	PHS Smoke, Percent Opacity	Transmission Gear No.	PHS Smoke, Percent Opacity
1500	150	7.0	5	5.0
1700	165	8.8	6	6.8
1900	190	10.3	7	9.8
2100	184	11.0	8	10.3
2200	150	8.0	9	8.8
			10	6.8

TABLE 60. EXHAUST EMISSIONS SUMMARY

(As-Measured)

Vehicle: 1968 Ford Tractor	Engine: Cummins NH-250 derated to 225
Date: July 22, 1969	Fuel: EM-90-F (No. 2 Diesel)

	Operating Conditions			
Constituent	Idle	150 hp at 1500 rpm	150 hp at 1800 rpm	150 hp at 2100 rpm
Hydrocarbons, ppm C	56	35	42	45
CO, ppm	165	2200	740	670
NO_x, ppm NO_2	110	1658	1230	898
NO, ppm	138	1456	1000	754
Total Aldehydes, ppm	21	15	20	21
Formaldehyde, ppm	7	4	8	9
Acrolein, ppm	2	2	3	3
CO_2, Percent	0.8	10.2	7.9	7.4

Odor and smoke results are summarized on Table 61. The odor ratings were higher during the idle ("D" 3.9) and decel ("D" 3.5) than the other conditions which were on the order of "D" 3.0. As with the NH-250 engine, the "B," "O," "A" ratings were on the order of 1.0. The pungent rating was higher than is normally encountered. The smoke measurements showed that this tractor emitted 28-percent opacity smoke at 2100 rpm. Injectors on this tractor had been replaced 60,920 miles before this evaluation and later inspection showed that the injector adjustment and preload was within specification. Other exhaust emissions are summarized on Table 62. The hydrocarbons and CO results are in general agreement with those obtained with the stationary dynamometer operated NH-220. For additional details on the operating procedures for this drag axle tractor, please refer to Appendix D Tables 62 through 72.

TABLE 61. ODOR AND SMOKE SUMMARY

Vehicle: 1965 White Freightliner
Date: August 5, 1969

Engine: Cummins NH-220
Fuel: EM-90-F (No. 2 Diesel)

Odor Summary, Q/I Average
(700:1 Dilution)

Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
35-mph cruise, 150 hp at 2100 rpm	2.7	0.9	0.9	0.8	0.4
37-mph cruise, 150 hp at 1800 rpm	2.8	1.0	1.0	0.9	0.3
40-mph cruise, 150 hp at 1500 rpm	3.0	1.0	0.9	0.8	0.2
Idle after cruise	3.9	1.0	1.0	0.9	0.5
Acceleration after idle	3.2	1.0	1.0	0.9	0.6
Acceleration	2.8	1.0	1.0	0.9	0.4
Deceleration after cruise	3.5	1.0	1.1	0.9	0.6

Smoke Summary, PHS Average

Constant Speed			Acceleration	
Engine Speed, rpm	Vehicle Power, hp	PHS Smoke, Percent Opacity	Transmission Gear No.	PHS Smoke, Percent Opacity
1500	150	20.3	5	11.0
1700	160	23.0	6	10.0
1900	165	29.0	7	14.0
2100	170	28.0	8	23.0
2200	180	27.3	9	25.0
			10	19.0

G. Summary

Six diesel-powered truck-tractors with a variety of engines and driveline combinations were investigated to determine the applicability of smoke and odor measurement procedures developed during Part I. Each evaluation required two to three days to conduct, limiting the availability of vehicles to rental agencies. The diesel tractor variety from rental agency restricted the engines to mostly naturally aspirated type. In all cases, however, in which single drive and dual exhaust stacks were involved, satisfactory modification to the existing dynamometer procedures could be made permitting acquisition of baseline odor, smoke, and other emissions data.

TABLE 62. EXHAUST EMISSIONS SUMMARY

(As-Measured)

Vehicle: 1965 White Freightliner
Date: August 5, 1969

Engine: Cummins NH-220
Fuel: EM-90-F (No. 2 Diesel)

Constituent	Operating Conditions			
	Idle	150 hp at 1500 rpm	150 hp at 1800 rpm	150 hp at 2100 rpm
Hydrocarbons, ppm C	370	259	309	391
CO, ppm	175	2000	2000	1929
NO_x, ppm NO_2	127	1508	1230	910
NO, ppm	194	1469	1200	854
Total Aldehydes, ppm	11	9	9	9
Formaldehyde, ppm	3	3	2	2
Acrolein, ppm	2	2	3	3
CO_2, percent	2	11	10	9

VII. VARIOUS DIESEL EMISSIONS MEASUREMENTS

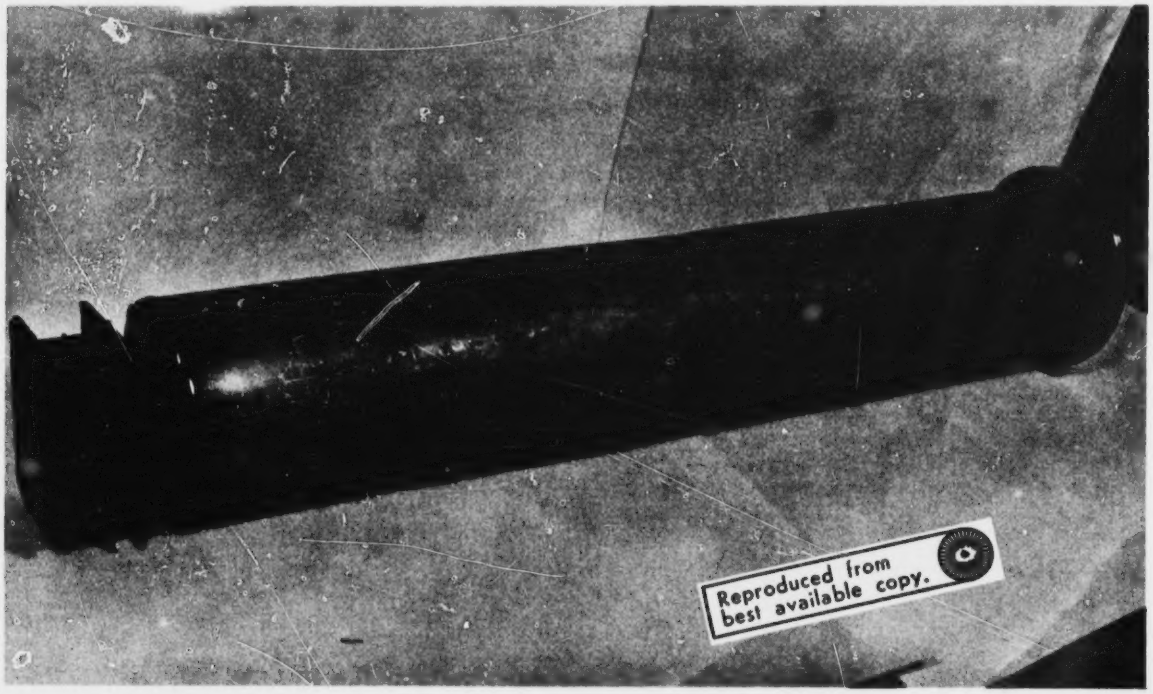
Several items of a miscellaneous nature were included in Part III for evaluation and study. They included evaluation of an electrostatic precipitator, cross-check of the SwRI and Bureau of Mines odor panels, a brief study of the effect of fuel on odor, and test of needle type injectors in Detroit Diesel 6V-71 E engines.

A. Evaluation of Electrostatic Precipitator

During the Part II project, an attempted evaluation of the Gourdine electrostatic precipitator was terminated by mechanical failure. The device was designed to remove smoke and carbon particulate from diesel exhaust. The first prototype, tested on November 22, 1967, failed mechanically due to acoustic pulsation before any quantitative analysis could be made. For a description of the initial test, please refer to the Part II Final Report (Ref. 3). The engine used for this test was a Cummins NH-220, naturally aspirated, four-cycle, six-cylinder engine. The fuel-air ratio of the engine was modified by partially restricting the inlet air simulating a partially clogged air cleaner such that relatively dense smoke was produced throughout the speed range investigated.

A repackaged unit, shown in Figure 52, was supplied for retest. Figure 53 is a schematic of the test apparatus used for baseline smoke measurements. The engine exhaust was routed through a cylindrical truck muffler, then through 8 ft of 4-in. diameter flexible exhaust pipe, and finally through 4 ft of 4-in. diameter straight exhaust pipe. The PHS smokemeter was mounted at the end of the 4-ft straight section with the light beam 5-1/2 in. from the tip of the pipe, and exhaust temperatures were monitored by the thermocouple shown.

Figure 54 shows the apparatus used for the evaluation of the Gourdine precipitator. In addition to the engine, muffler, and flexible pipe mentioned above, the exhaust was passed through a 10-ft section of 4-in. diameter straight exhaust pipe with an adapter on the downstream end to match the rectangular inlet of the precipitator. After passing through the inlet (ionizer/attractor section) of the device, the exhaust passed through the 7-1/2-in.-ID, 4-ft-long cylindrical collector. Finally, the exhaust went through a conical adapter and a 4-ft section of 4-in.-diameter straight exhaust pipe on



Reproduced from best available copy.

FIGURE 52. EXTERIOR OF GOURDINE EGD DIESEL PRECIPITATOR ASSEMBLY
(Flow Is Left-to-Right)

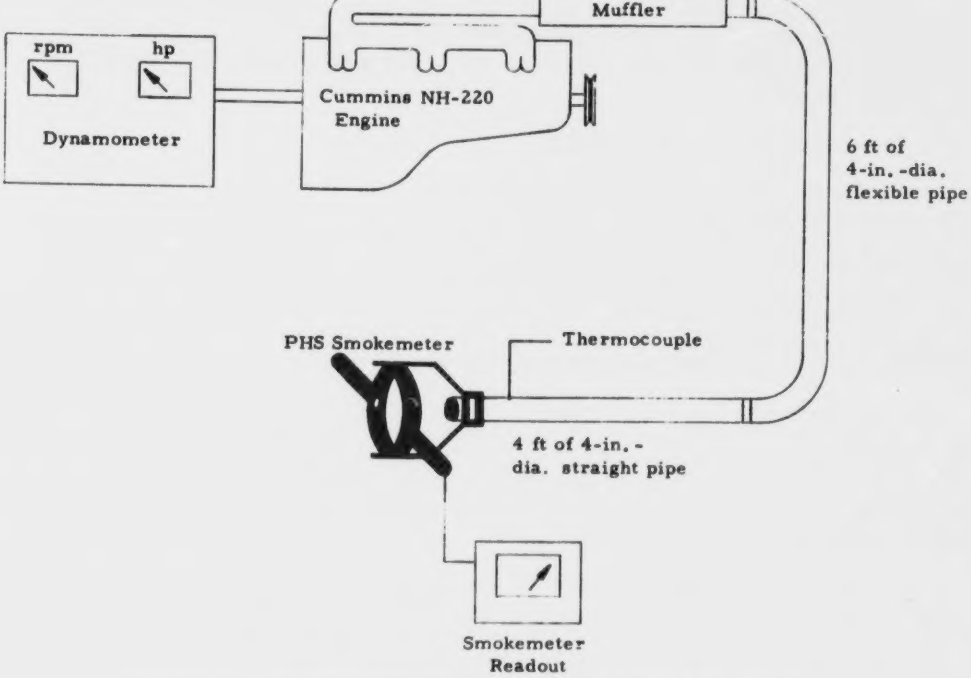

Muffler
rpm
hp
Cummins NH-220 Engine
Dynamometer
6 ft of 4-in.-dia. flexible pipe
PHS Smokemeter
Thermocouple
4 ft of 4-in.-dia. straight pipe
Smokemeter Readout

FIGURE 53. SCHEMATIC OF TEST APPARATUS USED FOR BASELINE SMOKE MEASUREMENT

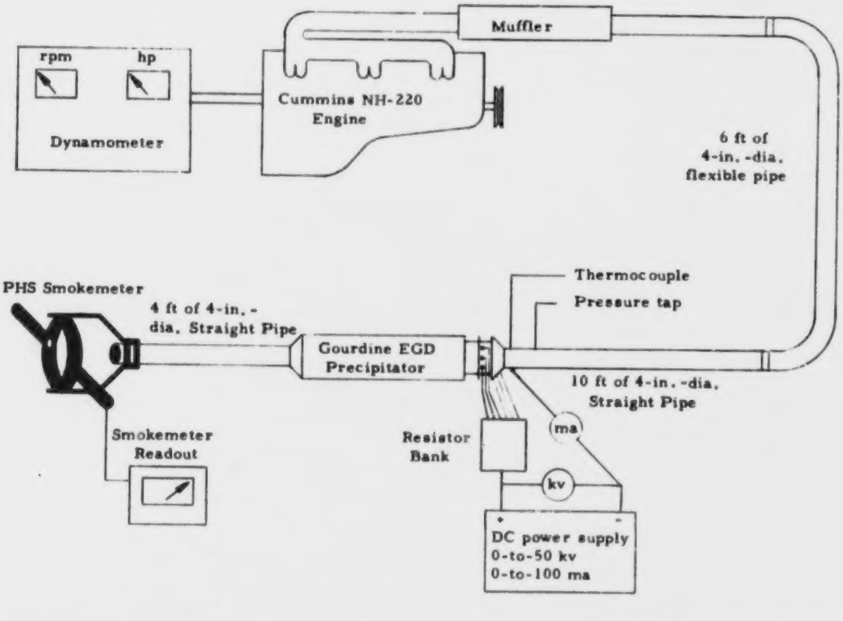

Muffler
rpm
hp
Cummins NH-220 Engine
Dynamometer
6 ft of 4-in.-dia. flexible pipe
Thermocouple
Pressure tap
PHS Smokemeter
4 ft of 4-in.-dia. Straight Pipe
Gourdine EGD Precipitator
10 ft of 4-in.-dia. Straight Pipe
ma
Smokemeter Readout
Resistor Bank
kv
+
-
DC power supply
0-to-50 kv
0-to-100 ma

FIGURE 54. SCHEMATIC OF TEST APPARATUS USED FOR EVALUATION OF GOURDINE EGD DIESEL PRECIPITATOR

which the PHS smokemeter was mounted with the light beam 5-1/2 in. from the tip of the pipe. Exhaust temperature and pressure drop across the precipitator were monitored by transducers mounted just upstream of the precipitator, as shown. Power requirements of the ionizer of the precipitator were met by a 0- to 50-kv, 0- to 100-ma-DC power supply, and the electrical input was measured by a 0- to 20-kv voltmeter and a 0- to 15-ma ammeter. Tables 63 and 64 list the electrical and smoke performance results, respectively, and will be discussed together.

TABLE 63. GOURDINE EGD IONIZER CURRENT AS A FUNCTION OF IONIZER VOLTAGE

Test(s)	Date	Condition
1	1/2/69	As-received, still air, ionizer cold
4-6	1/2/69	After 11 min running, still air, ionizer hot
8-10	1/2/69	After 26 min running, still air, ionizer hot
11, 12	1/3/69	After 26 min running, still air, ionizer cold
13, 14	1/3/69	After 26 min running, still air, ionizer cold, wires recentered
17-20	1/3/69	After 46 min running, still air, ionizer hot
21, 22	1/3/69	After 46 min running, still air, ionizer cold

	Current, ma																
Test	1	4	5	6	8	9	10	11	12	13	14	17	18	19	20	21	22
Voltage, kv																	
0.5	0	0.30	0.20	0.10	0.75	0.30	0.20	0.35	0.30	0.30	0.20	0.50	0.40	0.30	0.20	0.20	0.20
1	0	0.70	0.25	0.10	1.20	0.40	0.40	0.65	0.65	0.50	0.50	1.10	0.70	0.50	0.50	0.50	0.40
2	0	1.40	0.60	0.30	2.20	1.00	0.90	1.25	1.20	1.00	0.90	2.10	1.60	1.30	1.10	1.00	0.90
3	0	2.20	1.40	0.60	3.00	1.80	1.70	1.90	1.70	1.50	1.30	3.30	2.70	2.20	2.00	1.60	1.50
4	0	3.20	2.40	1.50	4.00	2.80	2.80	2.65	2.20	2.00	1.75	4.40	3.80	3.60	3.30	2.30	2.10
5	0	4.15	3.40	2.30	3.80	4.00	4.00	3.20	3.20	2.70	2.30	5.50	4.90	5.00	4.70	3.20	3.00
6	0	5.20	4.50	3.30	5.00	5.20	5.20	4.20	4.30	3.30	2.90	6.70	6.20	6.10	5.80	4.30	4.10
7	0	6.20	5.60	4.60	6.15	6.30	5.80	5.25	5.50	4.30	3.90	7.90	7.40	7.50	7.10	5.50	5.20
8	0.02	7.40	6.50	6.00	7.30	7.50	7.00	6.90	6.80	5.30	5.10	9.10	8.80	8.70	8.50	6.60	6.40
9	0.11	8.60	7.80	7.00	8.60	9.00	8.70	8.30	8.20	6.50	6.90	10.10	10.10	9.90	9.80	8.80	7.50
10	0.25	9.50	8.90	8.70	11.00	10.00	9.90	9.70	9.50	8.00	8.20	11.20	11.20	11.10	11.00	9.20	9.20

Test 1, Table 63, was conducted with the ionizer unit in the as-received condition, prior to the unit being placed in an exhaust stream, and, during this test, intermittent visible arcing was observed in the interior of the ionizer section at 8 kv. A continuous visible discharge was observed at 10 kv, so it was determined that 10 kv was above the maximum operating voltage of the ionizer. The manufacturer's voltage specification was 12 to 16 kv.

Test 2, Table 64, was run to obtain baseline smoke levels with the stock muffler and stock exhaust system illustrated in Figure 53. The stock smoke levels were purposely atypical for this engine though not impossible under normal truck operation. They ranged from 16- to 36-percent opacity over the 1300- to 2200-rpm speed range investigated. All engine smoke tests were conducted using EM-29-F, a known typical commercial no. 2 diesel fuel. Test 3 was conducted with the Gourdine unit installed as shown in Figure 54, but with the electrical system disconnected, thus providing a check on the efficiency of the precipitator as a mechanical filter. The data indicate that the precipitator did not filter mechanically.

Following the completion of test 3, tests 4 through 6 of Table 63 were conducted to determine whether or not the resistance of the ionizer had changed. Data taken in tests 4 through 6 indicate that the apparent ionizer resistance (equivalent series resistance) had decreased greatly after running 11 min, the value being in the range 0.25 to 2.0 MΩ, as compared to an initial resistance of 40 MΩ or more. This resistance change is thought to be due to deposition of carbon particles on the interior surfaces of the ionizer.

Test 7, the first smoke test with the Gourdine system operative, was conducted by holding the engine/dynamometer system at the previously used operating points, while voltage input to the ionizer was increased by increments of 2 kv over the range 0 to 10 kv and brought back to zero. It is apparent that neither presence nor magnitude of ionizer voltage had a measurable effect on smoke. Tests 8 through 14, Table 63, were performed following test 7 as a further check on the electrical properties of the Gourdine precipitator after running 26 min. As in tests 4 through 6, the apparent resistance of the ionizer was quite low, ranging from 0.11 to 1.7 MΩ.

TABLE 64. SMOKE DATA WITH AND WITHOUT THE GOURDINE EGD PRECIPITATOR OPERATIVE

Tests 2, 3, 7, 15, 16

Test*	rpm/hp	EMF, kv	I, ma	% Opac, PHS	T, °F	ΔP, in. H_2O
2	1300/125	--	--	16	710	--
	1500/134	--	--	21	790	--
	1700/145	--	--	21	840	--
	1900/162	--	--	30	940	--
	2100/170	--	--	36	1000	--
	2200/170	--	--	35	1020	--
3	1300/125	--	--	17	730	2.9
	1500/134	--	--	20	770	3.3
	1700/145	--	--	22	820	4.3
	1900/162	--	--	31	920	5.0
	2100/170	--	--	36	970	5.6
	2200/170	--	--	35	1000	5.9
7	1300/125	0	--	18	700	2.8
		2	--	17	700	2.8
		4	--	17	700	2.8
		6	--	17	700	2.8
		8	--	18	700	2.8
		10	--	17	700	2.8
		0	--	18	700	2.8
	1500/134	0	--	21	750	3.2
		2	--	21	750	3.2
		4	--	21	750	3.2
		6	--	21	750	3.2
		8	--	21	750	3.2
		10	--	21	750	3.2
		0	--	21	750	3.2
	1700/145	0	--	22	810	4.4
		2	--	22	810	4.4
		4	--	21	810	4.4
		6	--	21	810	4.4
		8	--	21	810	4.4
		10	--	21	810	4.4
		0	--	21	810	4.4
	1900/162	0	--	30	900	5.2
7 (cont'd)	1900/162 (cont'd)	2	--	30	900	5.2
		4	--	29	900	5.2
		6	--	29	900	5.2
		8	--	30	900	5.2
		10	--	30	900	5.2
		0	--	30	900	5.2
	2100/170	0	--	36	980	5.7
		2	--	35	980	5.7
		4	--	35	980	5.7
		6	--	35	980	5.7
		8	--	35	980	5.7
		10	--	35	980	5.7
		0	--	35	980	5.7
	2200/170	0	--	36	1020	5.9
		2	--	36	1020	5.9
		4	--	35	1020	5.9
		6	--	35	1020	5.9
		8	--	35	1020	5.9
		10	--	35	1020	5.9
		0	--	35	1020	5.9
15	1300/125	--	--	20	--	--
	1500/134	--	--	24	--	--
	1700/145	--	--	25	--	--
	1900/162	--	--	33	--	--
	2100/170	--	--	40	--	--
	2200/170	--	--	39	--	--
16	1300/125	0	0	19	520	2.4
		2	2.0	19	580	2.4
		4	4.1	19	640	2.4
		6	6.2	20	620	2.6
		8	8.6	20	660	2.6
		10	11.0	20	680	2.6
		0	0	20	660	2.6
	1500/134	0	0	24	720	3.2
16 (cont'd)	1500/134 (cont'd)	2	2.0	24	740	3.2
		4	4.2	24	760	3.2
		6	6.5	24	780	3.2
		8	8.9	24	780	3.2
		10	11.5	24	780	3.2
		0	0	24	800	3.2
	1700/145	0	0	26	820	4.0
		2	2.0	26	820	4.0
		4	4.2	25	820	4.0
		6	6.5	25	840	4.0
		8	9.0	25	840	4.0
		10	11.5	25	840	4.0
		0	0	25	840	4.0
	1900/162	0	0	34	880	5.0
		2	2.1	34	900	5.0
		4	4.4	33	920	5.0
		6	6.7	33	920	5.0
		8	9.2	33	940	5.2
		10	11.7	32	940	5.2
		0	0	33	940	5.2
	2100/170	0	0	40	980	5.4
		2	2.3	40	1000	5.4
		4	4.7	40	1000	5.6
		6	7.1	39	1020	5.4
		8	9.6	39	1020	5.4
		10	12.0	39	1020	5.4
		0	0	40	1020	5.4
	2200/170	0	0	40	1040	5.6
		2	2.3	40	1040	5.6
		4	4.8	40	1060	5.6
		6	7.2	39	1060	5.6
		8	9.7	39	1060	5.6
		10	12.3	39	1060	5.6
		0	0	40	1060	5.6

*Test	Date	Conditions
2	1/2/69	PHS smoke readings with stock exhaust system.
3	1/2/69	PHS smoke readings with Gourdine installed, no ionizer EMF.
7	1/2/69	PHS smoke readings with Gourdine installed and operating.
15	1/3/69	PHS smoke readings with stock exhaust system.
16	1/3/69	PHS smoke readings with Gourdine installed and operating.

Test 15, similar to test 2, was conducted for the purpose of establishing baseline smoke readings for January 3. Test 16 was then performed in the same way as test 7, except that ionizer current readings were taken at each operating point along with smoke readings. As in test 7, the Gourdine precipitator had no measurable effect on smoke. Tests 17 through 20 were conducted immediately following test 16, with the ionizer still hot. Tests 21 and 22 were run later, after the ionizer had cooled. Minimum resistance of 60 kΩ occurred with the ionizer hot, and maximum ionizer resistance of 1.67 MΩ occurred after the ionizer had cooled.

Since ionizer resistances varied with temperature and voltage, the resistance of each of the six elements of the ionizer was measured with an ohmmeter. Figure 55 shows a partial circuit diagram of the electrical system with measured resistances included. These measurements were taken after 46 min of operation and without any intentional carbon deposit removal. Analysis of this circuit yields a total resistance of 1.04 MΩ, and equivalent series resistance of 210 kΩ for the ionizer. The resistance of the ionizer section should ideally be infinite, but the observations made

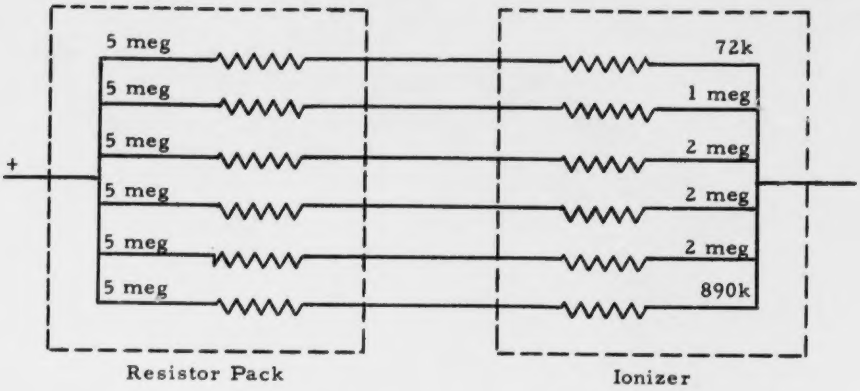

5 meg
5 meg
5 meg
5 meg
5 meg
5 meg
72k
1 meg
2 meg
2 meg
2 meg
890k
+
Resistor Pack
Ionizer

FIGURE 55. SCHEMATIC OF RESISTOR PACK AND IONIZER

during these tests show that a leakage path was present, presumably carbon deposits on ionizer surfaces.

Figure 56 is a photograph of the ionizer section in the as-received condition. It shows the insulator posts and interior surfaces looking from the gas inlet side (downstream). Figure 57 is an oblique view from the opposite side showing ionizer wires and supports as the unit was received. Figure 58 is similar to 57, and shows the carbon deposits after 46 min of operation.

Comparison of test 1 with tests 4 through 6, 8 through 14, and 17 through 22 shows that the ionizer initially operated in a theoretically correct manner (although voltages supposedly in the

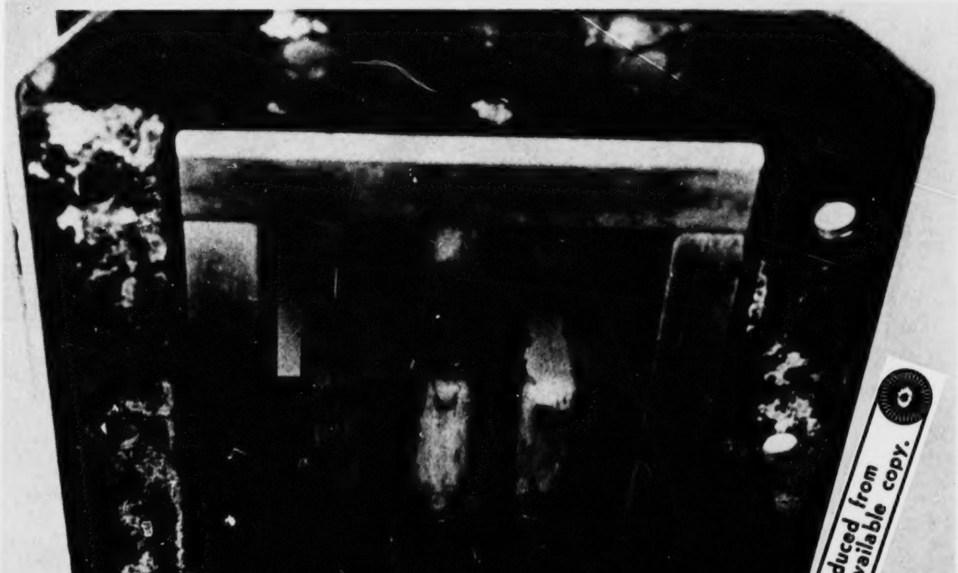

Reproduced from best available copy.
C-31797

FIGURE 56. GAS INLET SIDE OF IONIZER SECTION OF GOURDINE EGD DIESEL PRECIPITATOR IN AS-RECEIVED CONDITION, SHOWING INSULATOR POSTS AND INTERIOR SURFACES

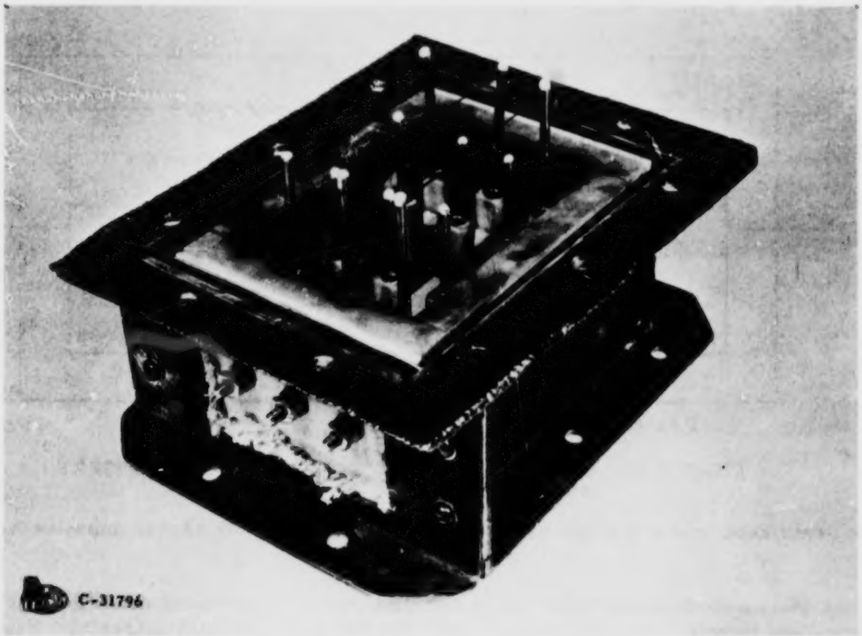
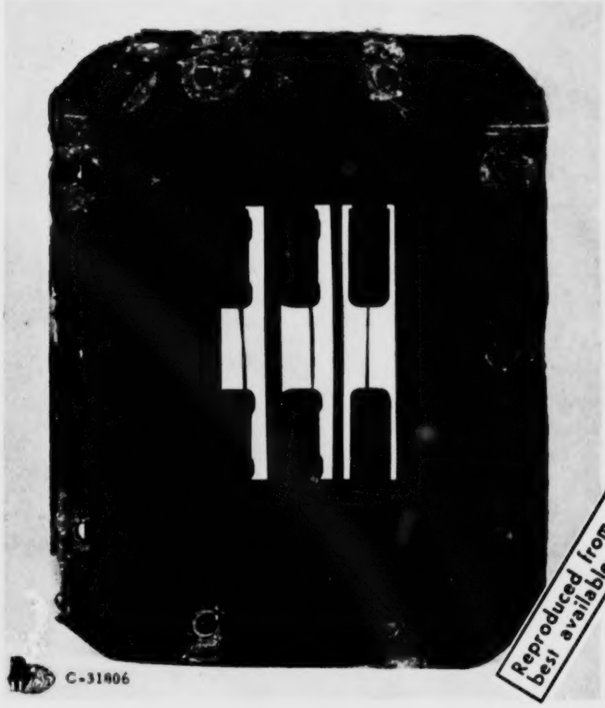


FIGURE 57. GAS DISCHARGE SIDE OF IONIZER SECTION OF GOURDINE EGD DIESEL PRECIPITATOR IN AS-RECEIVED CONDITION, SHOWING IONIZER WIRES, SUPPORTS, AND CONNECTORS



Reproduced from best available copy.

FIGURE 58. GAS INLET SIDE OF IONIZER/ATTRACTOR ASSEMBLY OF GOURDINE EGD DIESEL PRECIPITATOR SHOWING CARBON DEPOSITS AFTER 46 MINUTES OF ENGINE OPERATION

operating range of the ionizer were impossible to obtain without excessive sparkover), but that deposition of a conducting particulate (carbon) on ionizer surfaces soon provided a current leakage path. Smoke data in test 3 and with 0-kv EMF during tests 7 and 16 indicate that the Gourdine unit did not act as a mechanical particulate filter. When voltage was applied and the unit operated as an electrostatic precipitator, no reductions in smoke were found. This observation was true at all engine speed and power conditions, and at every applied voltage.

B. Bureau of Mines - SwRI Odor Panel Cross Check

In November 1967, at a meeting in Cincinnati with Mr. Dick Hurn, Bureau of Mines (Petroleum Research Center), Mr. Bob Squires, Scott Research, Dr. Amos Turk, and PHS officials, the correlation between panels using the PHS Q/I technique was discussed. It was felt that on the whole, fairly good correlation between the three labs existed regarding the overall "D" rating, the most important indicator of diesel odor. Although fairly good agreement on the four qualities existed between SRL and SwRI, overall agreement was less than desired between Bureau of Mines and SRL or SwRI.

As a result, it was mutually agreed that this be investigated by both Bureau of Mines and SwRI in a cooperative effort. To this end, four of the Bureau of Mines odor panel traveled to San Antonio and worked in conjunction with an equal number of SwRI panelists in the SwRI facility. The reason for conducting this program at SwRI was the ability to accommodate eight panelists plus observers simultaneously and to operate a variety of engines fairly quickly on either chassis or stationary dynamometers.

Both a typical two-cycle (Detroit Diesel 6V-71 E) and four-cycle (Cummins NH-220) were involved, the former mounted in a 45-passenger automatic transmission equipped municipal bus and the latter stationary operated. In addition to varying the operating conditions, two different dilution ratios were investigated with the two-cycle engine.

Table 65 compares the BM and SwRI overall average (four-run average of four panelists each for five operating conditions) response for "D," "B," "O," "A," and "P." Surprisingly good agreement may be noted for the "D," "B," and "O" ratings on exhaust from the two-cycle powered bus

TABLE 65. COMPARISON OF PANEL RATINGS AT 100:1
DILUTION LEVEL, TWO-CYCLE EXHAUST

Vehicle: Bus 677
Date: September 10-11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Odor Quality	Panel	Operating Condition				
		20 mph*	40 mph*	Idle	Idle-Acceleration	Deceleration
D	B of M	5.8	5.6	4.7	7.5	7.6
	SwRI	6.2	5.7	5.0	7.0	7.9
	Net Difference	+0.4	+0.1	+0.3	-0.5	+0.3
B	B of M	2.4	2.0	0.7	2.6	2.0
	SwRI	2.7	1.9	1.7	2.3	2.7
	Net Difference	+0.3	-0.1	+1.0	-0.3	+0.7
O	B of M	1.6	1.4	1.9	2.6	2.3
	SwRI	1.7	1.6	1.5	2.0	2.0
	Net Difference	+0.1	+0.2	-0.4	-0.6	-0.3
A	B of M	1.9	2.4	2.3	2.3	3.1
	SwRI	1.2	1.0	1.1	1.4	2.2
	Net Difference	-0.7	-1.4	-1.2	-0.9	-0.9
P	B of M	0	0	0	0	0
	SwRI	1.0	0.8	0.4	1.6	1.4
	Net Difference	+1.0	+0.8	+0.4	+1.6	+1.4

---

*Cruise at 40 hp, rear wheels.

operated on No. 1 diesel fuel at 100:1 exhaust dilution level. Difficulties are evident in the "A" and "P" ratings in which the results seem to be opposite in trend. In other words, the BM panel is higher in "A" rating and lower in "P" rating relative to the SwRI panel. Another slight difficulty is the idle ratings, particularly the burnt rating of 0.7 (BM) compared to 1.7 (SwRI). It was as if the BM panel was not "getting" this condition and this was mentioned by the BM panel during the course of the two days of work.

The next comparison, Table 66 of the text, is for the four-cycle exhaust odor also at 100:1 dilution but with a No. 2 diesel fuel. Again, the agreement between panels appears satisfactory even though the four-cycle odor is different in quality from the two-cycle odor. Only three conditions were investigated: an idle, a part load, and a near full load condition at 1800-rpm engine speed. As with the two-cycle engine, the agreement is fairly good for the "D," "B," and "O" ratings except during the idle condition. The differences in idle appeared greatest in the "B" (BM 0.5 vs SwRI 1.8), the "O" (BM 2.2 vs SwRI 1.2), and the "A" (BM 2.3 vs SwRI 1.4). Most other conditions had much better agreement.

TABLE 66. COMPARISON OF PANEL RATINGS AT 100:1 DILUTION LEVEL, FOUR-CYCLE EXHAUST

Engine: Cummins NH-220
Date: September 10, 1968

Fuel: EM-29-F (No. 2 Diesel)

Odor Quality	Panel	Operating Condition		
		Idle	Part Load*	Full Load†
D	B of M	5.0	5.0	5.1
	SwRI	5.4	5.7	5.4
	Net Difference	+0.4	+0.7	+0.3
B	B of M	0.5	2.2	2.7
	SwRI	1.8	1.9	2.0
	Net Difference	+1.3	-0.3	-0.7
O	B of M	2.2	1.5	1.0
	SwRI	1.2	1.5	1.3
	Net Difference	-1.0	0	+0.3
A	B of M	2.3	1.3	1.4
	SwRI	1.4	1.5	1.2
	Net Difference	-0.9	+0.2	-0.2
P	B of M	0.1	0.2	0.1
	SwRI	0.3	0.5	0.2
	Net Difference	+0.2	+0.3	+0.1

---

*50 hp obs at 1800 rpm.

†150 hp obs at 1800 rpm.

The final analysis was to determine the ability of both panels to follow changes in dilution of the exhaust. Shown on Table 67 are the average results for two-cycle bus exhaust diluted at 100 and 300:1 under 20- and 40-mph cruises and a warm idle. Overall, neither panel could be fooled by a change in dilution. This is reflected by the minus (-) in front of the net change, indicating a decrease in intensity at 300 relative to 100:1. In most cases, the magnitude of reduction shows fairly good agreement, although a few instances are difficult to explain. The "A" responses, though quite different between panels, showed almost the same net change which is interesting.

The almost total lack of pungent odor, according to the BM panel, and significantly higher "A" quality were discussed after the 2 days of operation. It appears that odors not possible to classify with the kit may have been lumped in with the aromatic-aldehydic (light and sweet) quality resulting in a high rating relative to SwRI. As reported originally, the SwRI panel is trained to ask themselves

TABLE 67. PERFORMANCE OF PANELS AT TWO DIFFERENT DILUTION RATIOS

Vehicle: Bus 677 Date: September 10-11, 1968

Odor Quality	Dilution Ratio	20 mph*		40 mph*		Idle	
		B of M	SwRI	B of M	SwRI	B of M	SwRI
D	100:1	5.8	6.2	5.6	5.7	4.6	5.0
	300:1	3.4	4.5	3.6	3.5	3.3	4.1
	Net Change	-2.4	-1.7	-2.0	-2.2	-1.3	-0.9
B	100:1	2.4	2.1	2.0	1.9	0.7	1.5
	300:1	1.1	1.6	0.8	0.9	0.3	1.3
	Net Change	-1.3	-0.5	-1.2	-1.0	-0.4	-0.2
O	100:1	1.6	1.7	1.4	1.6	1.9	1.5
	300:1	1.1	1.2	1.3	1.0	1.2	1.1
	Net Change	-0.5	-0.5	-0.1	-0.6	-0.7	-0.4
A	100:1	1.9	1.2	2.4	1.0	2.3	1.1
	300:1	1.3	0.7	1.6	0.9	1.8	0.8
	Net Change	-0.6	-0.5	-0.8	-0.1	-0.5	-0.3
P	100:1	0	1.0	0	0.8	0	0.4
	300:1	0	0.3	0	0.1	0	0.4
	Net Change	0	-0.7	0	-0.7	0	0

---

*Cruise at 40 hp, rear wheels.

this question automatically: Is "D," "B," "O," "A," or "P" present and if so, how much? Accordingly, some odors may not be classified by the current Q/I kit. In this case, written descriptions are requested of the panel and employed to gain additional insight. The SwRI panel periodically refers to the Q/I standards. By periodic, this is meant prior to the first run each day and as often as each panelist feels necessary during the course of a 5-hr day. It is uncertain whether periodic use of the Q/I kit is optimum although this is another possible apparent difference in panel operation. As to the difference in odor perception during the hot idle condition, additional runs will probably be necessary to investigate and determine reasons for this.

In summary, the comparison overall between the two panels appears better than was originally thought. It is felt that the satisfactory level of agreement with the "D" standard can be reached with all four of the qualities by panel training experience. The four qualities which comprise the overall composite seem equal in importance to the overall composite in describing and characterizing the exhaust odor from a diesel engine.

C. Effect of Fuel Type on Exhaust Odor

During a training period in May 1968, a two-cycle powered municipal bus was inadvertently connected to a supply of No. 2 diesel fuel, normally used with truck-tractor type vehicles. The odor panel readily detected a difference in the odor relative to that normally experienced from buses fueled with No. 1 kerosene type fuel exclusively used during the previous 2 years of work. At the end of the day, it was realized that a No. 2 fuel was mistakenly used and, on the next day, the same vehicle and same conditions were operated except with the No. 1 fuel. The character and quality of the diesel exhaust odor returned to that typical of previously evaluated two-cycle powered buses.

On October 23 and 24, 1968, a different but similar type two-cycle powered municipal bus was operated, first with a No. 2 fuel and then with a No. 1 fuel, essentially repeating the procedure described above. The properties of the No. 1 and No. 2 fuels are listed on Table 2. The No. 2 fuel was a heavier material with a higher boiling range, higher cetane number, and contained more aromatics than the No. 1 diesel fuel. The operating conditions were those routinely employed with two-cycle powered buses.

TABLE 68. COMPARISON OF ODOR PANEL RESPONSES FOR NO. 1 VS NO. 2 DIESEL FUEL

Vehicle: Bus 687

Date: October 23-24, 1968

Operating Conditions	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph 40 hp	No. 2	6.9	2.3	2.0	1.5	1.3
	No. 1	5.4	1.9	1.6	1.2	1.0
	Difference	-1.5	-0.4	-0.4	-0.3	-0.3
	U_s Statistic	0	--	0.5	0	--
30 mph 40 hp	No. 2	6.4	2.0	1.8	1.6	1.1
	No. 1	5.7	1.6	1.6	1.3	1.1
	Difference	-0.7	-0.4	-0.2	-0.3	0
	U_s Statistic	--	--	--	--	--
40 mph 40 hp	No. 2	6.3	2.0	1.9	1.4	1.0
	No. 1	5.7	1.9	1.7	1.2	1.0
	Difference	-0.6	-0.1	-0.2	-0.2	0
	U_s Statistic	--	--	--	--	--
Idle	No. 2	5.9	1.9	1.7	1.4	1.0
	No. 1	6.0	1.9	1.7	1.5	1.1
	Difference	+0.1	0	0	+0.1	+0.1
	U_s Statistic	--	--	--	--	--
Idle-Accel	No. 2	7.5	2.5	2.1	1.8	1.3
	No. 1	6.7	2.1	2.0	1.4	1.4
	Difference	-0.8	-0.4	-0.1	-0.4	+0.1
	U_s Statistic	0	0	--	0	--
Decel	No. 2	7.3	2.4	2.1	1.6	1.1
	No. 1	6.5	2.1	2.0	1.4	1.3
	Difference	-0.8	-0.3	-0.1	-0.2	+0.2
	U_s Statistic	1.5	--	--	--	--

Shown on Table 68 is a comparison of the overall four-run average panel ratings, first for the No. 2 and then for the No. 1 fuel for the six conditions investigated. The minus sign in front of the difference values indicates less intensity with the No. 1 fuel. Only during the idle did there fail to be a reduction indicated by this straight numerical comparison. The reductions in "D" ratings ranged from a difference of 0.6 to 1.5. The most obvious of the four qualities, the burnt rating, showed a difference of up to 0.4 with the No. 1 fuel. The same type of reduction was also noted with the "O" oily and lesser reductions for "A" and "P," the least obvious of the qualities. When subjected to a statistical analysis, the No. 2 fuel appeared to be different from the No. 1 ratings only under three operating conditions. A statistical difference was noted for the "D" rating during the 20-mph cruise and the acceleration after prolonged idle and deceleration after cruise. "B," "O," and "A" ratings were affected only in the 20-mph cruise and idle-accel conditions. This analysis would lead one to conclude that the effect of the No. 2 diesel fuel relative to the No. 1 material is not consistent. The underlying fact, however, is that the odor panel was not fooled in either instance though totally unaware of the nature of the experiment. Their comments were that the No. 2 fuel gave a stronger, more intense, penetrating, and lasting type of odor and it did not represent an improvement over that with the No. 1 diesel fuel. For further details and a complete listing of the odor panel responses, please refer to Appendix E Tables 5 through 7.

D. Effect of Injectors on Emissions

Most municipal buses are powered by the Detroit Diesel 6-71 engine in an inline or "Vee" configuration. Older engines designated "E" may have the crown type or "S" injector while newer engines are equipped with needle or "N" injectors. In many engines, the injectors are interchangeable though most operators keep "S" injectors in "E" engines and "N" injectors in "N" engines. A 60N unit injector is shown in Figure 59. Figure 60 is a cutaway drawing(10) showing the design features and differences between the standard (S) injector and the needle injector.

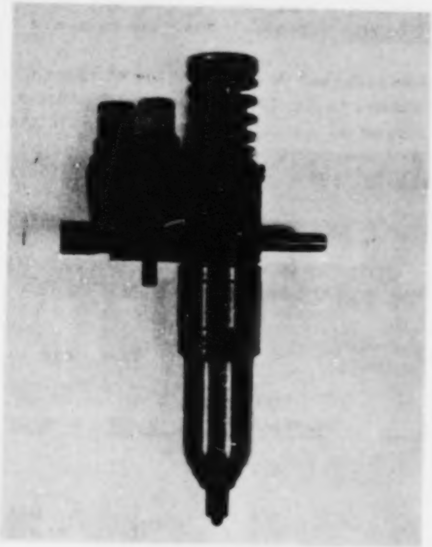
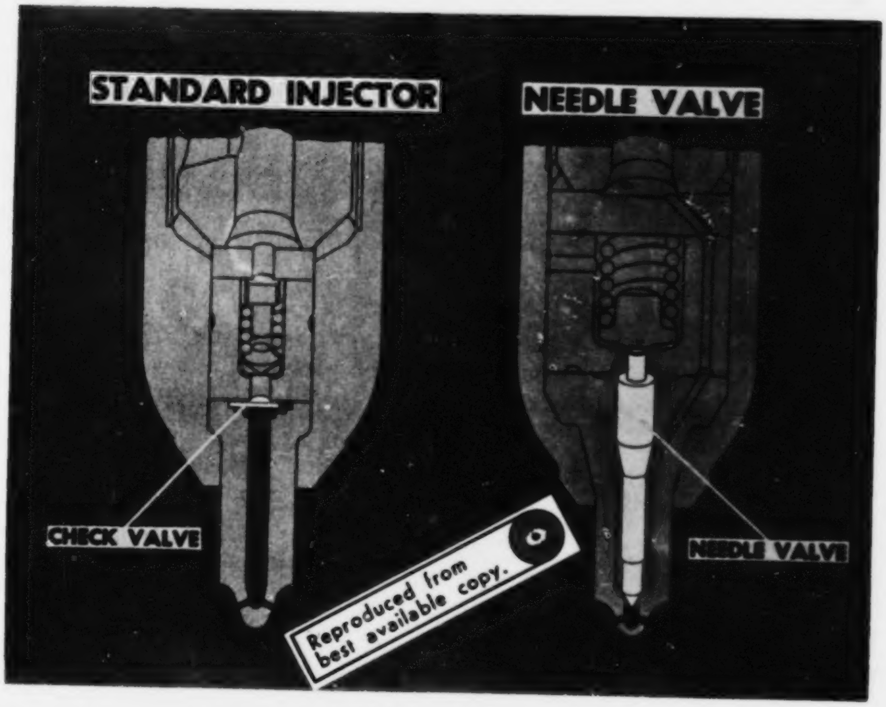


FIGURE 59. SIZE 60 N UNIT INJECTOR USED IN 71 SERIES TWO-CYCLE DETROIT DIESEL ENGINES


STANDARD INJECTOR
NEEDLE VALVE
CHECK VALVE
NEEDLE VALVE

Reproduced from best available copy.

FIGURE 60. CUTAWAYS OF STANDARD AND NEEDLE VALVE UNIT INJECTOR SPRAY TIPS USED IN TWO-CYCLE ENGINES

Recently, an improved needle injector called the "low-sac" "N" injector was developed and a new, flow calibrated set of "N" and "low-sac" injectors were furnished by the manufacturer for back-to-back evaluation. As the "low-sac" injector was not released for production at the time of evaluation, they were coded "X." The first experiment was the "N" and "X," both size 60, operated in a municipal bus powered by an E type 6V-71 engine for which baseline data were available.

Operating conditions and measurement procedures were identical to those used with other municipal buses. The results are shown in Tables 69, odor; 70, smoke; and 71, other emissions. The net change and U_s results are based on a comparison of the 60N and 60X results. The "S" injector results are listed for comparison purposes and were gained with used instead of new injectors. The 60S data were obtained on March 19, 1969, during the final evaluation of the Code "W" muffler on Bus 677.

TABLE 69. COMPARISON OF ODOR PANEL RESPONSE FOR 60N VS 60X TYPE INJECTORS

Vehicle: Bus 677
Date: April 30 and May 1, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Injector	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	60S	4.7	1.3	1.1	1.0	0.8
	3/19/69					
	60N	4.2	1.5	1.0	0.8	0.7
	60X	3.9	1.4	1.1	0.9	0.5
	Net Change	-0.3	-0.1	-0.1	+0.1	-0.2
	U_s Statistic	*	*	*	*	*
30 mph at 40 hp	60S	4.6	1.4	1.1	1.1	0.8
	3/19/69					
	60N	3.5	1.2	0.9	0.8	0.4
	60X	3.5	1.0	1.0	0.8	0.4
	Net Change	0	-0.2	+0.1	-0	-0
	U_s Statistic	*	*	0.5	*	*
40 mph at 40 hp	60S	4.9	1.5	1.1	1.0	0.8
	3/19/69					
	60N	3.8	1.1	0.9	0.9	0.6
	60X	3.8	1.1	0.9	0.9	0.4
	Net Change	-0	-0	0	-0	-0.2
	U_s Statistic	*	*	*	*	*
Idle	60S	5.3	1.6	1.2	1.1	0.9
	3/19/69					
	60N	5.0	1.7	1.2	1.2	0.8
	60X	5.4	1.7	1.2	1.0	0.9
	Net Change	-0.4	-0	-0	-0.2	+0.1
	U_s Statistic	*	*	*	*	*
Idle-Acceleration	60S	5.6	1.8	1.4	1.2	1.0
	3/19/69					
	60N	5.2	1.6	1.4	1.1	0.9
	60X	5.0	1.5	1.1	1.1	0.7
	Net Change	-0.2	-0.1	-0.3	-0	-0.2
	U_s Statistic	*	*	1	*	*
Deceleration	60S	5.7	1.9	1.5	1.3	1.1
	3/19/69					
	60N	3.9	1.3	0.9	0.9	1.7
	60X	3.7	1.2	1.0	0.9	1.6
	Net Change	-0.2	-0.1	+0.1	0	-0.1
	U_s Statistic	*	*	*	*	*

---

*U_s Statistic greater than 2, no statistical difference apparent.

TABLE 70. COMPARISON OF SMOKE READINGS FOR 60N INJECTORS VS 60X INJECTORS

Vehicle: Bus 677
Date: April 29 and 30, 1969 Fuel: EM-70-[illegible] (No. 1 Diesel)

Constant Speed Results (All open rack, maximum output)

Type Operation	Vehicle Speed, mph	Load hp	PHS Smoke Reading, Percent Opacity		
			Max	Min	Avg
A. 60S (3/19/69)					11.0
60N	20	44	8	7	7.7
60X	20	46	7	7	7.0
Net Change					-0.7
B. 60S (3/19/69)					8.0
60N	25	60	5	5	5.0
60X	25	60	5	5	5.0
Net Change					0
C. 60S (3/19/69)					5.7
60N	30	74	4	4	4.0
60X	30	72	4	4	4.0
Net Change					0
D. 60S (3/19/69)					5.0
60N	35	82	3	3	3.0
60X	35	84	3	3	3.0
Net Change					0

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of Engine			
60S (3/19/69)			6.0
60N	5	5	5.0
60X	4	4	4.0
Net Change			-1.0
During Acceleration			
60S (3/19/69)			6.3
60N	4	4	4.0
60X	4	4	4.0
Net Change			0
After Upshift			
60S (3/19/69)			6.0
60N	4	4	4.0
60X	4	4	4.0
Net Change			0

TABLE 71. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s STATISTICAL ANALYSIS - 60N VS 60X INJECTORS

Operating Conditions	Injector	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
I 20 mph 40 hp	60S (3/19/69)	388	3.8	1427	2	18	10	1011	1030	48
	60N	565	4.2	544	2	20	4	1043	1090	35
	60X	478	4.0	215	2	21	3	1072	1140	43
	U_s Statistic	*	*	0	*	*	1.5	*	0	1
II 30 mph 40 hp	60S (3/19/69)	210	3.1	1398	2	14	7	817	825	51
	60N	156	3.3	427	2	19	6	881	870	34
	60X	136	3.3	180	2	21	2	1066	903	45
	U_s Statistic	*	*	0	*	1	0	1.5	0	0
III 40 mph 40 hp	60S (3/19/69)	210	3.1	1398	2	14	7	817	825	51
	60N	133	3.2	499	2	20	8	835	754	33
	60X	128	3.1	186	2	21	2	800	789	44
	U_s Statistic	*	*	0	*	*	0	*		0
IV Idle	60S (3/19/69)	301	0.8	586	3	22	9	269	243	51
	60N	270	0.9	154	3	30	4	266	258	40
	60X	261	0.9	156	2	28	6	263	258	48
	U_s Statistic	*	*	0	0	*	1.5	*	*	0.5

---

*U_s Statistic greater than 2, no statistical difference apparent.

Though the net changes shown on Table 69 for the "X" relative to the "N" injector appear relatively minor, the new "N" versus the old "S" injectors resulted in a substantial improvement under all operating conditions except idle. Please note that the "S" data were obtained on March 19, while the "N" and "X" data were obtained on April 30 and May 1.

The Table 69 odor data have been combined and presented in the form of bar graphs in Figure 61. This figure shows a comparison of the sum of the four-run average "D" + "B" + "O" + "A" + "P" ratings for the new sets of N type injectors. These totals are superimposed on similar type scores obtained with the used set of "S" injectors and indicate the ability of the "N" and "X" injectors to reduce odor under all conditions except idle.

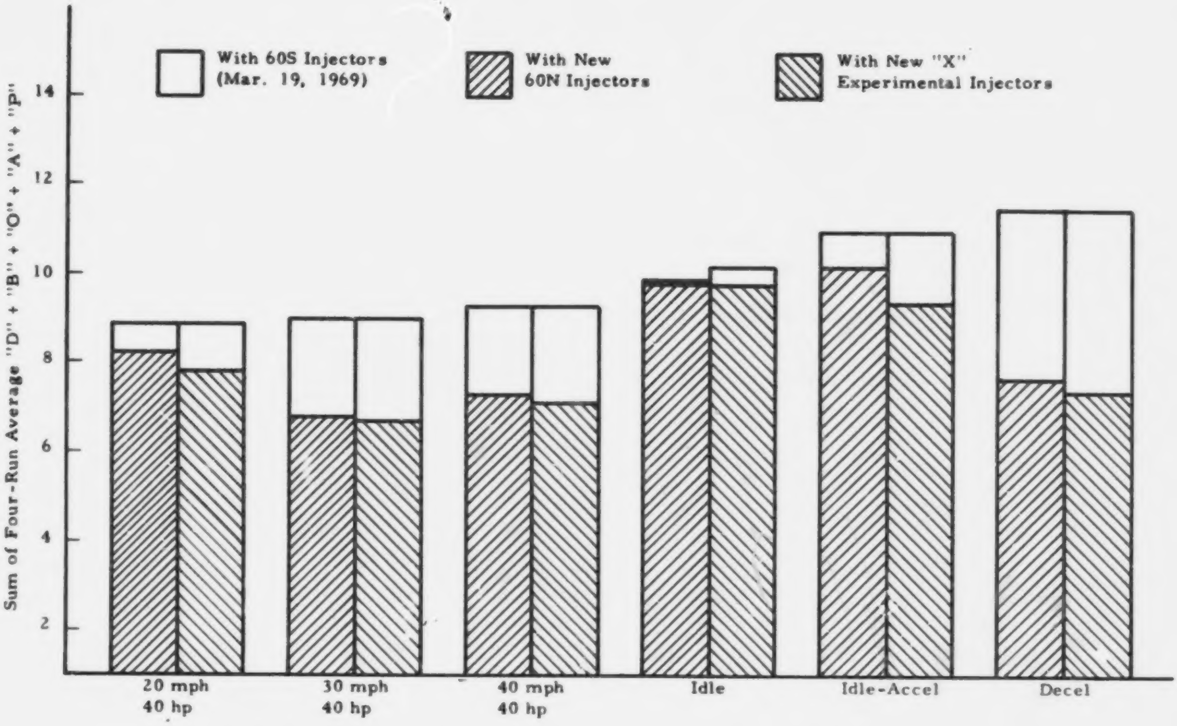


FIGURE 61. COMPARISON OF ODOR RATINGS FROM 6V-71 E POWERED BUS 677 EQUIPPED WITH NEW "N" AND EXPERIMENTAL ("X") INJECTORS

Likewise, the smoke readings (Table 70) showed little difference between the "N" and "X" injectors while the "N" versus the 'S" injector showed a marked reduction in visible smoke. The other emissions measured are listed in Table 71 and indicate that hydrocarbons and CO were reduced when the "X" injector was used instead of the "N" injector. Comparing the "N" injector with the "S" injector revealed an even greater effect, particularly in lowering unburned hydrocarbons. Formaldehyde likewise appeared to be affected under some of the conditions. In achieving lower hydrocarbons and CO, the CO_2 and NO seemed to increase some.

The results of this single engine vehicle back-to-back evaluation of "N" versus "X" injectors indicated that the experimental injectors are technically but not grossly different in odor and other emissions than the set of "N" injectors furnished by the manufacturer. However, when this same data from the "N" injectors is related to the standard engine with used 60S injectors, substantially greater performance improvements may be noted in odor, smoke, and hydrocarbons. On this basis, it would seem that the use of the needle "N" type injector in place of the "S" type injector normally employed in the 6V-71 E, 17.0:1 compression ratio engine, which is powering some of the municipal buses in current operation across the United States, would appear to be a step in the right direction.

Another back-to-back experiment was made in Bus 681 with the new "N" injectors compared to the stock configuration. The vehicle was operated with the usual 60S injectors in a used but maintained condition as it was brought from bus service, and then the injectors were replaced with new N units. Operating procedures, method of analysis, etc., were identical to those used previously and resulted in a comparison shown in Tables 72 (odor), 73 (smoke), and 74 (emissions). Only in three out of a possible thirty instances did the U_s fail to indicate a statistical difference in odor as perceived by the SwRI panel. The changes were significantly different with "D" change running from 0.5 at idle to 2.5 during the decel condition. Likewise, the burnt ratings were reduced from 0.4 to 0.8 bottle numbers. The less obvious yet important odor qualities of "O," "A," and "P" were also reduced.

To illustrate the effect of the new injectors on odor, the total four-run average "D" + "B" + "O" + "A" + "P" ratings have been plotted on the bar chart in Figure 62. This bar chart is a direct comparison and indicates the substantial improvement gained by use of the new set of injectors under all conditions, including a small improvement during the idle condition. It should be mentioned that for the past 2 years, during which time a number of odor control methods have been evaluated, this is the first instance in which substantial reductions under practically all conditions have been noted.

In a similar way, the observed smoke was reduced to about 1/4 to 1/2 by means of the needle type injectors. This consistent reduction in smoke was noticed under both transient as well as constant speed type conditions. The other emissions are shown on Table 74. Less CO, hydrocarbons, acrolein, aldehydes, and formaldehyde was recorded, particularly hydrocarbons. NO was increased slightly while NO_2 was essentially unchanged. In all instances, the reductions were indicated as statistically different. The reductions in CO, hydrocarbons, and acrolein may be considered as gross changes while the aldehydes-formaldehyde reduction was less percentage-wise.

TABLE 72. COMPARISON OF ODOR PANEL RESPONSES FOR 60S INJECTORS VS 60N EXPERIMENTAL INJECTORS

Vehicle: Bus 681
Date: May 28 and 29, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Injector	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	60S	5.0	1.6	1.2	1.1	0.7
	60N	2.6	0.8	0.7	0.6	0.1
	Net Change	-2.4	-0.8	-0.5	-0.5	-0.6
	U_s Statistic	0	0	0	0	0.5
30 mph at 40 hp	60S	4.3	1.2	1.1	1.0	0.6
	60N	3.0	0.9	0.9	0.8	0.3
	Net Change	-1.3	-0.3	-0.2	-0.2	-0.3
	U_s Statistic	2	0.5	1	*	1.5
40 mph at 40 hp	60S	4.4	1.3	1.2	1.0	0.6
	60N	2.5	0.9	0.8	0.6	0.2
	Net Change	-1.9	-0.4	-0.4	-0.4	-0.4
	U_s Statistic	0	0	0	0	0.5
Idle	60S	4.9	1.6	1.3	1.1	0.8
	60N	4.4	1.2	0.9	1.0	0.7
	Net Change	-0.5	-0.4	-0.4	-0.1	-0.1
	U_s Statistic	2.0	0	0	1.5	*
Idle-Acceleration	60S	6.3	2.1	1.6	1.2	1.1
	60N	4.8	1.4	1.1	1.1	0.6
	Net Change	-1.5	-0.7	-0.5	-0.1	-0.5
	U_s Statistic	0	0	0	*	0
Deceleration	60S	6.4	2.0	1.8	1.5	1.2
	60N	3.9	1.2	0.9	1.0	0.5
	Net Change	-2.5	-0.8	-0.9	-0.5	-0.7
	U_s Statistic	0	0	0	0	0

---

*U_s Statistic greater than 2, no statistical difference apparent.

TABLE 73. COMPARISON OF SMOKE READINGS FOR 60S INJECTORS VS 60N EXPERIMENTAL INJECTORS

Vehicle: Bus 681
Date: May 28 and 29, 1969
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (Allopen rack, maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
			Max	Min	Avg
A. 60S	20	46	12	11	11.7
60N	20	50	5	4	4.7
Net Change					-7.0
B. 60S	25	58	10	9	9.7
60N	25	60	3	3	3.0
Net Change					-6.7
C. 60S	30	68	8	8	8.0
60N	30	68	2	2	2.0
Net Change					-6.0
D. 60S	35	80	7	7	7.0
60N	35	78	2	2	2.0
Net Change					-5.0

Transient Operation: Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of Engine			
60S	6	6	6.0
60N	3	2	2.7
Net Change			-3.3
During Acceleration			
60S	8	7	7.7
60N	2	2	2.0
Net Change			-5.7
After Upshift			
60S	7	7	7.0
60N	2	2	2.0
Net Change			-5.0

TABLE 74. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s STATISTICAL ANALYSIS - 60S VS 60N INJECTORS

Vehicle: Bus 681
Date: May 27 and 29, 1969
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Injector	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
I	60S	970	5.6	1265	5.2	32.7	10.7	872	808	54
20 mph	60N	365	5.4	458	2.4	14.1	4.2	930	970	43
40 hp	U_s Statistic	0	0	0	0	0	0	0	0	0
II	60S	250	4.3	974	3.7	20.1	7.2	705	640	58
30 mph	60N	180	4.2	394	2.2	15.5	3.7	820	720	49
40 hp	U_s Statistic	0	1.5	0	0	1	0	0.5	0	0
III	60S	200	4.2	835	3.7	19.6	10.9	612	570	49
40 mph	60N	165	4.1	278	2.1	15.5	3.7	774	640	42
40 hp	U_s Statistic	1	1	0	0	0	0	1	0	0
IV	60S	235	1.1	487	3.5	19.6	6.2	219	210	57
Idle	60N	250	1.2	302	2.3	17.4	6.6	243	280	54
	U_s Statistic	2	*	0	0	*	1.5	1	0	2

---

*U_s Statistic greater than 2, no statistical difference apparent.

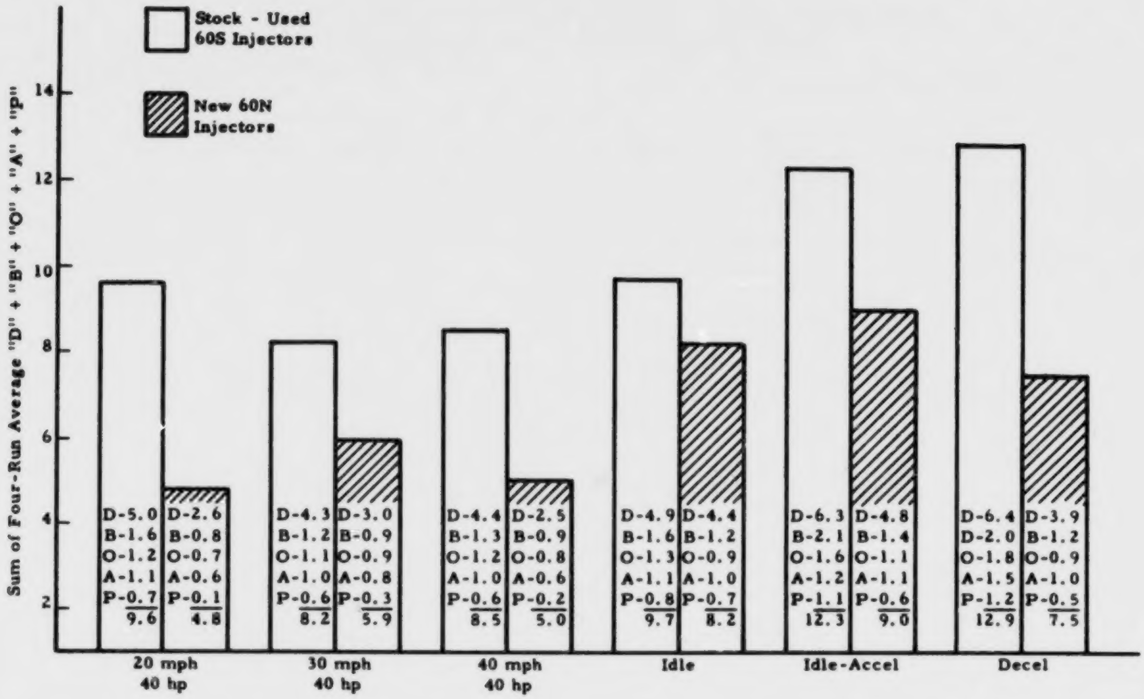


FIGURE 62. COMPARISON OF ODOR RATINGS FROM 6V-71 E POWERED BUS 681 EQUIPPED WITH USED "S" AND NEW "N" TYPE INJECTORS

A final series of experiments were made to compare the new "X" injectors with the used stock "S" injectors in Bus 681. The odor measurements are summarized on Table 75 and indicate the significant effect these new injectors had on perceived odor. Only in a few instances did the U statistic fail to show a statistical difference. In most instances, U_s was equal to 0 and, in light of the net change values, may be termed a significant difference. The improvements possible with the new set of low sac or "X" injectors is illustrated in Figure 63 for each of the five operating conditions.

The smoke results are compared in Table 76 and show a 50- to 75-percent reduction in visible smoke. Table 77 lists the exhaust emissions and indicates the dramatic effect the low-sac injectors had on hydrocarbons (a reduction to about 10 to 20 percent of the "S" injector) with lesser reductions in CO, total aldehydes, and formaldehyde. A recent service bulletin(11) advises that new "low-sac volume" spray tips are being used in all "N" injectors.

In summary, it appears that the use of needle type injectors in place of the "S" injectors appears to be an attractive method for reducing diesel emissions from this type of engine. Initial contacts with vendors of replacement units indicate that an S-type injector can be exchanged for an N-type injector at a nominal additional cost to the basic repair and overhaul cost. In conclusion, it appears that a fleet test of "N" or the improved "N," low-sac, injectors should be considered to confirm the performance and investigate the deterioration with time.

TABLE 75. COMPARISON OF ODOR PANEL RESPONSES FOR 60S INJECTORS VS LOW-SAC INJECTORS

Vehicle: Bus 681
Date: July 29 and 30, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Injector	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph - 40 hp	60S	5.3	1.7	1.2	1.1	1.0
	Low Sac	2.9	1.1	1.0	0.9	0.5
	Net Change	-2.4	-0.6	-0.2	-0.2	-0.5
	U_s Statistic	0	0	1	2	0
30 mph - 40 hp	60S	5.1	1.7	1.3	1.1	1.0
	Low Sac	2.4	0.9	0.9	0.8	0.4
	Net Change	-2.7	-0.8	-0.4	-0.3	-0.6
	U_s Statistic	0	0	1	0	0
40 mph - 40 hp	60S	5.2	1.7	1.3	1.1	1.0
	Low Sac	2.9	1.0	0.9	0.9	0.4
	Net Change	-2.3	-0.7	-0.4	-0.2	-0.6
	U_s Statistic	0	0	0	*	0
Idle	60S	4.6	1.5	1.2	1.1	0.9
	Low Sac	4.0	1.1	1.1	1.1	0.7
	Net Change	-0.6	-0.4	-0.1	0	-0.2
	U_s Statistic	*	0	*	*	*
Idle-Acceleration	60S	6.3	2.0	1.5	1.3	1.2
	Low Sac	4.6	1.6	1.3	1.2	1.0
	Net Change	-1.7	-0.4	-0.2	-0.1	-0.2
	U_s Statistic	0	0	*	*	1
Deceleration	60S	5.4	1.8	1.1	1.3	1.0
	Low Sac	3.2	1.1	1.1	1.0	0.6
	Net Change	-2.2	-0.7	0	-0.3	-0.4
	U_s Statistic	0	0.5	*	1	0

---

*U_s statistic greater than 2, no statistical difference apparent.

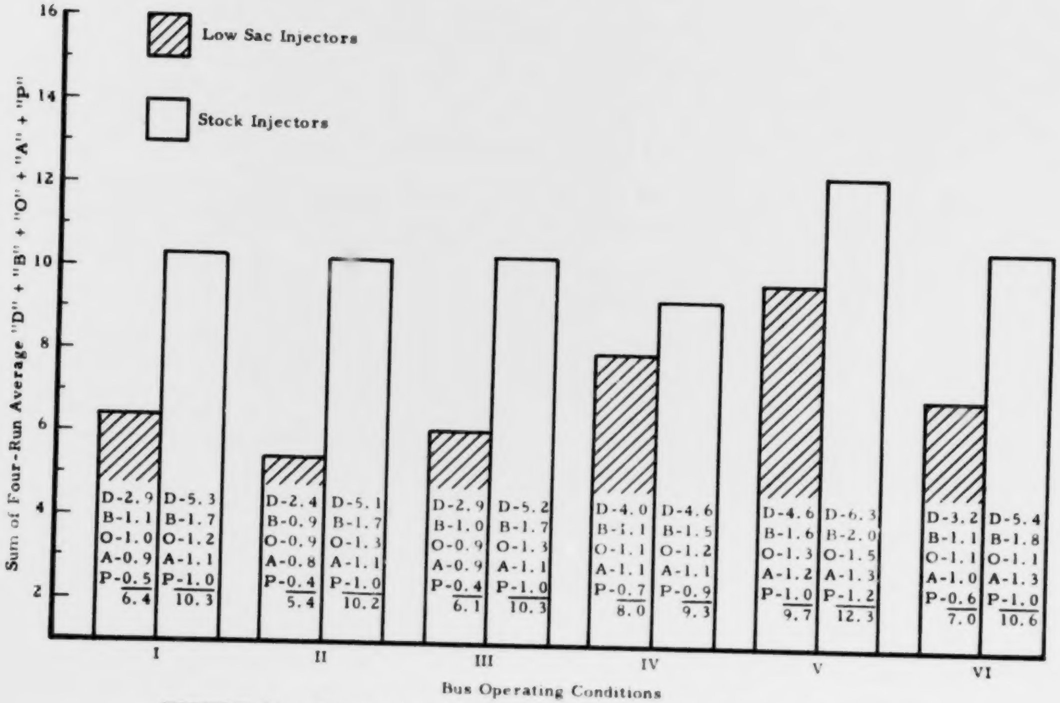


FIGURE 63. OVERALL COMPARISON OF DIESEL EVALUATION OF 60S VS LOW-SAC INJECTORS

TABLE 76. COMPARISON OF SMOKE READINGS FOR 60S INJECTORS VS LOW-SAC INJECTORS

Vehicle: Bus 681
Date: July 29 and 30, 1969

Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (All open rack, maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity Max	Min	Avg
60S	20	50	10	10	10.0
Low Sac	20	48	5.5	5	5.3
Net Change					-4.7
60S	25	59	8.5	8	8.2
Low Sac	25	62	3.5	3	3.3
Net Change					-4.9
60S	30	69	7.5	7	7.2
Low Sac	30	78	3	2.5	2.8
Net Change					-4.4
60S	35	82	6	6	6.0
Low Sac	35	84	2.5	2	2.2
Net Change					-3.8

Transient Operation: Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of Idle-Acceleration	PHS Smoke Readings, Percent Opacity Max	Min	Avg
Start of Engine	13	12	12.3
60S	13	12	12.3
Low Sac	1	1	1.0
Net Change			-11.3
During Acceleration			
60S	7	6.5	6.8
Low Sac	2.5	2	2.2
Net Change			-4.6
After Upshift			
60S	6	6	6.0
Low Sac	3	3	3.0
Net Change			-3.0

TABLE 77. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s STATISTICAL ANALYSIS 60S VS EXPERIMENTAL LOW-SAC INJECTORS

Vehicle: Bus 681
Date: July 29 and 30, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Injector	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
20 mph 40 hp	60S	662	5.5	2057	3	30	7	1242	744
	Low Sac	227	5.5	248	2	20	2	1352	1050
	U_s Statistic	0	*	0	1	0	1	1	0
30 mph 40 hp	60S	228	4.6	1967	2	27	4	1017	606
	Low Sac	118	4.8	229	2	20	2	1135	856
	U_s Statistic	0	*	0	0	0	*	0	0
40 mph 40 hp	60S	185	4.4	1857	2	26	5	892	569
	Low Sac	98	4.5	188	2	21	3	991	763
	U_s Statistic	0	*	0	*	0	2	0	0
Idle	60S	212	1.2	909	2	26	6	338	213
	Low Sac	132	1.2	188	2	23	4	396	281
	U_s Statistic	0	*	0	*	*	*	0.5	0

---

*U_s statistic greater than 2, no statistical difference apparent.

VIII. INVESTIGATION OF INSTRUMENTAL METHODS FOR ODOR MEASUREMENTS

Characterization of diesel odor is a difficult task, so difficult that human judgment must be relied on. Using the PHS odor Q/I kit, much progress has been made to measure odor by means of a trained panel. In an attempt to extend the usefulness of the panel, several instrumental methods have been considered. Each had to meet criteria of simplicity, ease of operation, repeatability and reproducibility and, most important, correlation with the odor panel must be demonstrated.

A. Review of Part II Preliminary Study

Much of the initial work, reported in detail in the Part II final report, Reference 3, made use of the exhaust from a single cylinder GM Detroit Diesel 1-71 two-cycle, single-cylinder engine. A variety of trap methods and liquid phase scrubbing agents were tried with continuous direct sampling and Tedlar plastic bag samples. It was found that a considerable amount of odor was removed by slowly bubbling the raw exhaust through distilled water. Some hydrocarbons were also removed but, on standing, collected as a thin film over the water and effectively separated themselves from the water bottom. The hydrocarbons in diesel exhaust have been extensively analyzed by gas-liquid chromatography (GLC) and other methods and have been shown by a number of investigators as well as SwRI to be similar to raw diesel fuel with complicated chromatograms characterized by large humps with numerous small peaks. Instead of directing the initial research efforts along these well-known paths, the water bottom, which contained most of the odor not characterized as fuel or kerosene in odor, was analyzed by mass spectroscopy (MS). These analyses revealed that the water bottom contained mostly polar compounds such as aldehydes, alcohols, ketones, and ethers.

The next step was to select a suitable column material and GLC conditions to analyze the water bottom. The decision was made to use GLC instead of mass spectral analysis as one of the goals was to develop a simple, inexpensive reproducible analytical tool. GLC, though time-consuming to develop into a workable method, seemed to meet this requirement for widespread straightforward implementation better than the mass spectrometer.

Porapak Q was selected as the column packing as this material has a relatively high separation efficiency for polar compounds and reported results using this type of column were encouraging for this application. To gain as short an analysis time as possible yet obtain adequate separation, as well as minimizing baseline drift, a fairly short column and isothermal chromatograph conditions were selected as follows:

Carrier gas: Nitrogen
Carrier gas flow: 25 ml/min
Sample Size: 1 to 2 μl
Column dimensions: 4-ft × 1/8-in. SS
Column packing: 50/80 Porapak Q
Detector temperature: 180°C

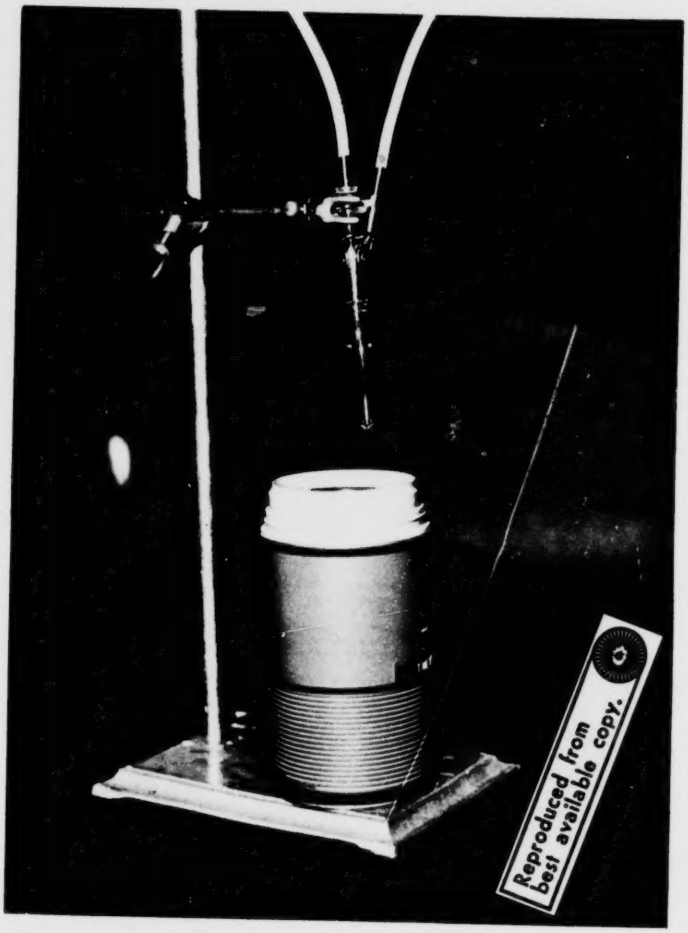
Hydrogen flow: 25 ml/min
Airflow: 350 ml/min
Range: 0.1
Attenuation: 2
Column temperature: 180°C
Injector temperature: 240°C

Instrument: Varian 600-D gas chromatograph with FID
Recorder: Leeds and Northrup Model W with disc integrator

The sum total result of the Part II preliminary study was the formulation of a tentative technique for odor measurement. Although unproven and not correlated with the odor panel, the technique suggested use of bag sampling (Tedlar) of hot idle raw engine exhaust followed immediately by gas washing in an aqueous solution for removal of most of the odorous compounds. A portion of the resulting washed odor would then be injected into the chromatograph at the above set of operating conditions.

B. Technique Development

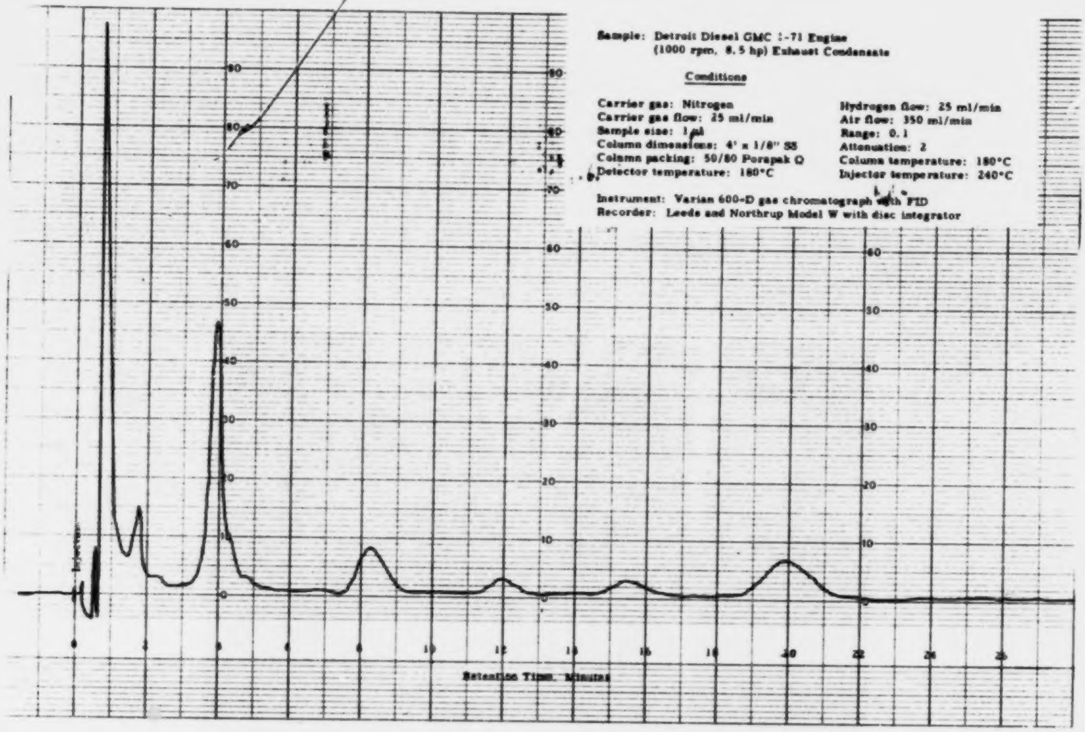
Initial efforts during Part III were to develop a system to the point for use in correlation experiments. Though the GLC column and operating conditions were fairly well set at the conclusion of Part II, much remained to be done, especially with the sampling and trapping technique. This covered the acquisition of the sample until its injection into the chromatograph. Though water seemed to remove most of the odor, the resulting solution was very weak making analysis and detection overly difficult. A number of different reagents including water, 1 and 5% $NaHCO_3$ aqueous solutions with one and two gas washing bubblers at flow rates of 0.25, 0.5, and 1.0 l/min exhaust flows were evaluated. Cold trapping at dry ice-alcohol (-76°C) and at ice water (0°C) temperatures was also investigated using up to six consecutive traps at 0.25, 0.5, and 1.0 l/min. The odor evaluations before and after the trap indicated optimum removal of the odor, from $D_8B_3O_2A_2P_2$, raw exhaust, to $D_2B_1O_1A_0P_0$ using the dry ice-alcohol (-76°C) trap. The residual odor at the D_2 level was very faint and difficult to perceive and seemed independent of the number of traps as long as the flow rate was 0.25 l/min. The trap is shown in Figure 64 prepared for immersion into the alcohol-dry ice cold bath contained in the wide-mouth Thermos jar.



Reproduced from best available copy.

FIGURE 64. TRAP AND LOW TEMPERATURE COLD BATH FOR REMOVAL OF DIESEL EXHAUST ODOR

Cold trapped exhaust condensate from the single-cylinder, two-cycle, 1-71 engine was then analyzed by the GLC method. Three conditions, a 1000-rpm, 8.5-hp load ($D_8B_2O_2A_2P_1$) and no load ($D_8B_1O_1A_1P_1$), and a hot idle (500 rpm) ($D_5B_1O_1A_1P_1$) were sampled and the resulting chromatograms are shown in Figures 65, 66, and 67. Essentially five or six peaks were found under all three conditions. The chromatogram obtained at 1000-rpm and 8.5-hp load, Figure 64, is much different from the 1000-rpm, no load and hot idle (no load 500 rpm) chromatograms, Figures 66 and 67. A large, off-scale peak was found during the no load conditions which was not recorded with the loaded condition. Compounds with higher molecular weight were present in the 1000-rpm, 8.5-hp load sample as evidenced by the small but noticeable peaks with fairly long retention times. These peaks were not distinguishable with the other two samples evaluated.



Sample: Detroit Diesel GMC 1-71 Engine
(1000 rpm, 8.5 hp) Exhaust Condensate

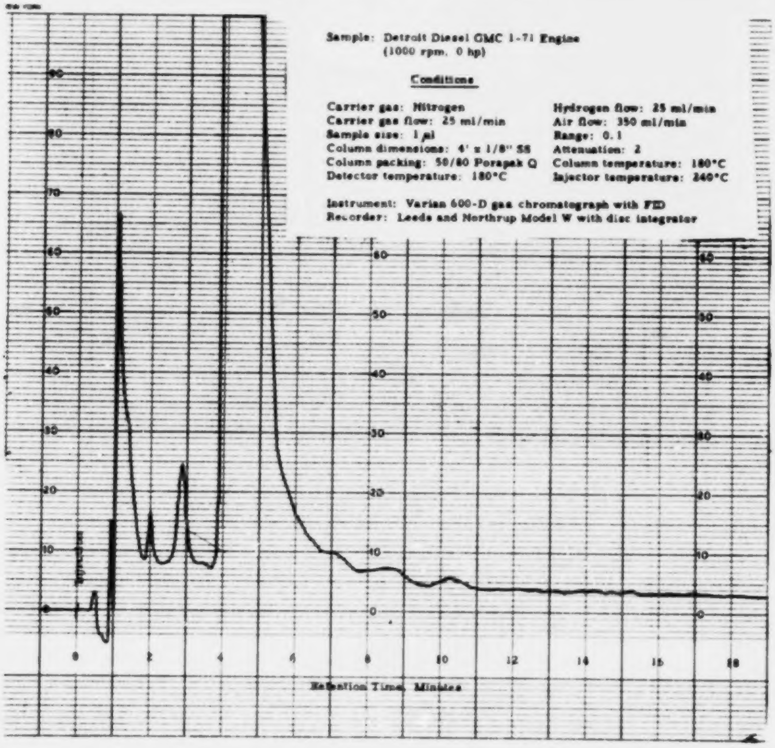
Conditions

Carrier gas: Nitrogen
Carrier gas flow: 25 ml/min
Sample size: 1 µl
Column dimensions: 4' x 1/8" SS
Column packing: 50/80 Porapak Q
Detector temperature: 180°C
Hydrogen flow: 25 ml/min
Air flow: 350 ml/min
Range: 0.1
Attenuation: 2
Column temperature: 180°C
Injector temperature: 240°C

Instrument: Varian 600-D gas chromatograph with FID
Recorder: Leeds and Northrup Model W with disc integrator

Injection
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Retention Time, Minutes
10
20
30
40
50
60
70
80
90

FIGURE 65. GAS CHROMATOGRAM OF GMC 1-71 EXHAUST CONDENSATE AT 1000 RPM AND 8.5 HP



Sample: Detroit Diesel GMC 1-71 Engine
(1000 rpm, 0 hp)

Conditions

Carrier gas: Nitrogen
Carrier gas flow: 25 ml/min
Sample size: 1 µl
Column dimensions: 4' x 1/8" SS
Column packing: 50/80 Porapak Q
Detector temperature: 180°C
Hydrogen flow: 25 ml/min
Air flow: 350 ml/min
Range: 0.1
Attenuation: 2
Column temperature: 180°C
Injector temperature: 240°C

Instrument: Varian 600-D gas chromatograph with FID
Recorder: Leeds and Northrup Model W with disc integrator

Injection
0
2
4
6
8
10
12
14
16
18
Retention Time, Minutes
10
20
30
40
50
60
70
80
90

FIGURE 66. GAS CHROMATOGRAM OF GMC 1-71 EXHAUST CONDENSATE AT 1000 RPM AND 0 HP

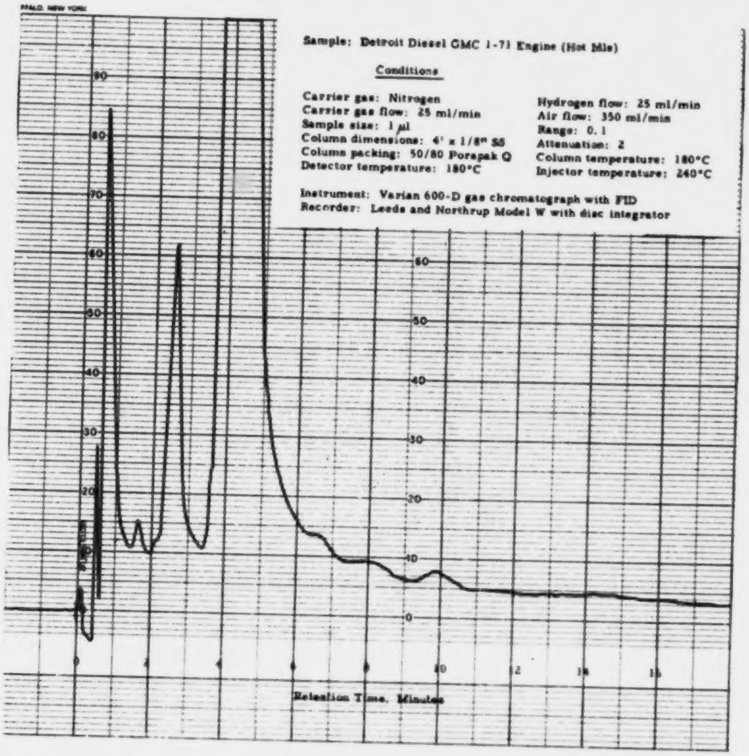


FIGURE 67. GAS CHROMATOGRAM OF GMC 1-71 EXHAUST CONDENSATE AT IDLE (500 RPM)

Though the chromatograms of Figures 65, 66, and 67 were encouraging, further refinement was needed before attempting correlation. Work then commenced on developing the total sampling trapping and condensate transfer procedure with the guidelines of simplicity, economy, repeatability, and speed so that a number of runs could be sampled each day. Normal chemistry-odor panel procedure is to run four engine-vehicle conditions in quadruplicate for 16 runs in the morning to allow chemical analyses in the afternoon of the wet collected samples for formaldehyde, total aldehydes, NO_x, acrolein, and SO_2. Operation of buses on the dynamometer is limited to 3 min per run due to tire heating and possible failure. Accordingly, a Dia Pump Model 08-405-73 with a Viton A diaphragm is used to withdraw the sample from the laboratory exhaust stack at the same point odor and other samples are obtained. The high flow capacity of this pump results in 2 to 3 cu ft of raw exhaust being placed in the Tedlar sample bag during the minute the panel evaluates the dilute odor. All connections in the exhaust sampling system are either stainless or Teflon with short lines and minimal residence or hang-up. No filtration or intentional heating-cooling is given the exhaust and the pump is operated prior to sampling to ensure that the system is flushed out, all lines are hot, and that the sample will be representative.

Once the sample is obtained, it is immediately brought into the analytical lab and connected to a system shown schematically in Figure 68. The exhaust gas is pulled by means of a low flow Neptune Model 4K vacuum pump through a cold trap held at -76°C. The trap is maintained at -76°C in a small thermos by a dry ice (CO_2) and isopropyl alcohol bath. The flow through these cold traps is maintained at 250 ml/min. Once the exhaust gas has passed through the cold trap for the predetermined sampling period, the pump is turned off, the cold bath removed, and the trap allowed to return to room temperature. A syringe with an 8-in., 15-gauge needle is used to transfer the liquid exhaust condensate from the trap to a small sample vial. The tubes in the glass traps become restricted due to the condensation of a sample on the walls. If this occurs, it is necessary to turn the pump off, remove the cold trap, and allow the trap to warm slightly. This allows the liquified sample to migrate by gravitational force to the bottom of the trap and thereby frees the previously restricted tube in the trap. During this period, there is no flow of the exhaust gas samples in the Tedlar bag through the trap. A sampling time of about 2 hr yields approximately 0.5 to 1.0 ml of exhaust condensate sample. This amount is sufficient for both GLC and mass spectrometric analyses. For analysis by GLC alone, somewhat less sample is needed and a trapping time of 1 hr was used.

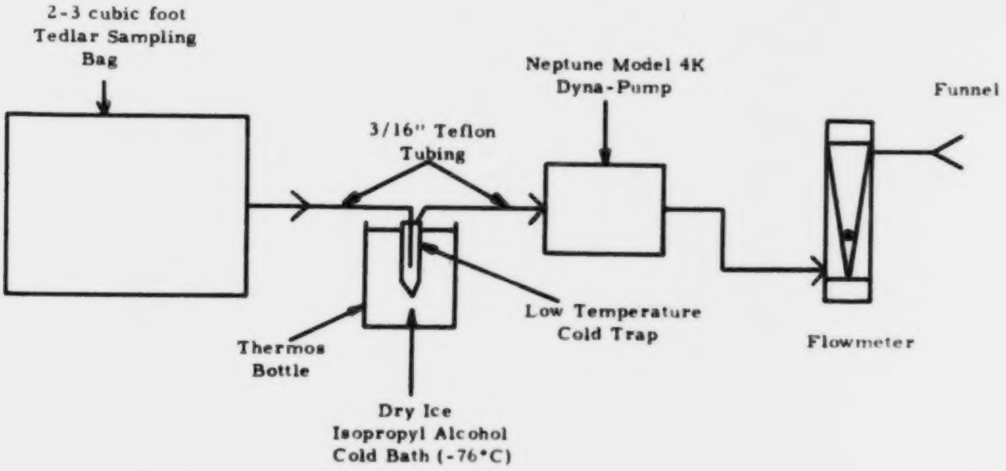

2-3 cubic foot
Tedlar Sampling
Bag
Neptune Model 4K
Dyna-Pump
Funnel
3/16" Teflon
Tubing
Low Temperature
Cold Trap
Flowmeter
Thermos
Bottle
Dry Ice
Isopropyl Alcohol
Cold Bath (-76°C)

FIGURE 68. DIESEL EXHAUST CONDENSATE SAMPLING TRAIN

Four complete cold trapping apparatus were used to collect different samples simultaneously. Figure 69 shows the battery of four traps and the associated flowmeters, pumps, etc. The 250-ml/min flow through the cold trap apparatus permits fairly efficient removal of the odorous components of diesel exhaust. Practically all odor is removed by passing the exhaust sample through the trap, and the efficiency can be monitored by means of a funnel attached to the exit of the flowmeter (Figure 69). This small Pyrex glass funnel allows periodic evaluation of the effluent from the cold trap for residual odor levels, changes in the efficiency of the trapping system, etc. It also permits rating of the effluent by a trained odor panelist(s).

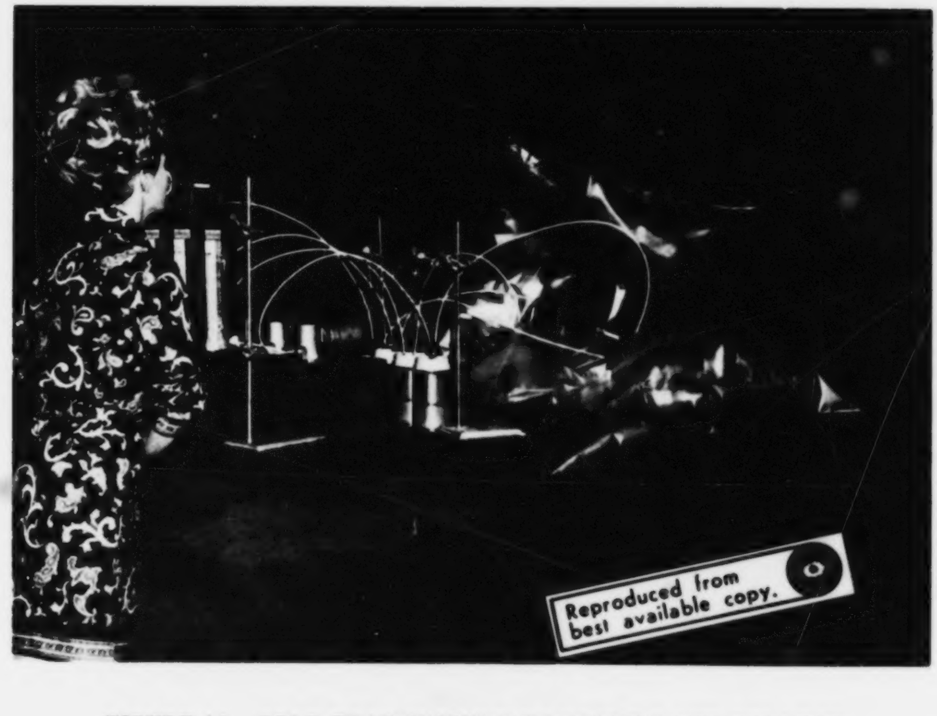
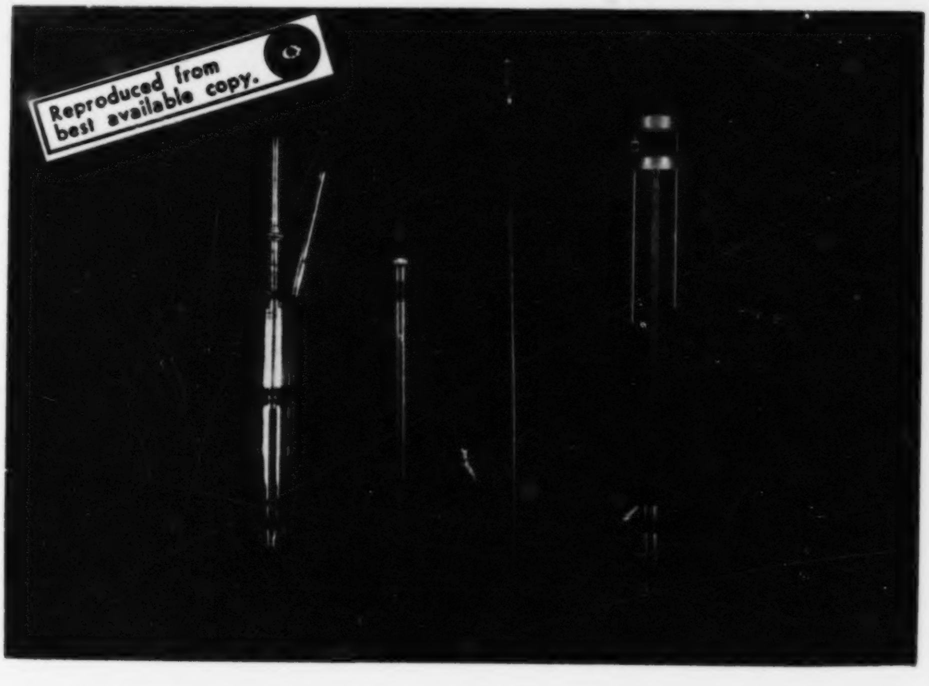

Reproduced from
best available copy.

FIGURE 69. COLD TRAP SYSTEMS TO REMOVE AND COLLECT
ODOR FROM FOUR SAMPLES AT THE SAME TIME

The traps are cleaned by rinsing with tap water several times then rinsed several times with distilled water. These traps are then connected to a drying tube filled with drierite, covered with electrical heating tape, and insulated. The remaining outlet of the trap is attached to a vacuum pump. In this manner, a stream of warm dry air passes through the tube, and no extraneous drying solvents are used. At one time, acetone and diethyl ether were used as the last rinse; however, it is very difficult to remove all of the cleaning material from the traps. This was checked by adding about 2 ml of distilled water to a trap which had been cleaned by using acetone as the drying material. This water solution was then removed, labeled, and injected into the gas chromatograph just as all other exhaust condensate samples were treated. This was done with five separate traps with acetone and five traps with diethyl ether. In all ten cases, the cleaning material (acetone or diethyl ether) was found to be present in the water. These traps appeared visually to be dry, although small quantities of the rinse were still found to be present. In the same manner, traps which were dried by using the vacuum-dry air technique were also evaluated in the same way, i.e., 2 ml of distilled water was added to the dried trap, removed according to normal sample treatment, and injected into the gas chromatograph. In all five of these cases, no extraneous peaks, other than the water peak, were observed to be present. In a similar aspect, a rigid transfer and injection syringe-cleaning procedure was followed. The cold trap, sample transfer needle and syringe, sample storage vial, and chromatograph injection syringe are shown in Figure 70.



Reproduced from best available copy.

FIGURE 70. TRAP, SAMPLE TRANSFER NEEDLE AND SYRINGE, SAMPLE VIAL AND INJECTION SYRINGE

With the development of sampling, trapping, and transfer methods, attention was next given to improving the GLC resolution. Instead of holding the column temperature constant, better resolution especially of the lighter molecular weight species, would be obtained by starting at a relatively low temperature and increasing the temperature with time. The flame detector is located in the oven and, at the maximum sensitivity settings needed with the inexpensive Varian 600D, temperature programming can cause baseline drift.

Due to low concentration of the odorous components in exhaust condensate, several steps were taken to increase sample response in the gas chromatograph. First, the sample size was standardized at $1\ \mu l$. Second, the attenuation was lowered to a setting of 1 rather than the original setting of 2.

The column and detector temperature was also lowered 10° to 170°C; otherwise, the GC conditions remained the same as listed earlier.

The next step was to apply the GLC technique to full scale engines and vehicles and gain operating experience. Shown in Figure 71 are GC traces for a 6V-71E Detroit Diesel powered bus under a hot idle ($D^{5.7}$, $B^{1.8}$, $O^{1.5}$, $A^{1.1}$, $P^{1.0}$) and a 20-mph, 40-hp cruise ($D^{6.3}$, $B^{2.0}$, $O^{1.8}$, $A^{0.9}$, $P^{1.3}$) which indicate a difference between the two conditions. With these encouraging results, the next step was to confirm that if the GC peaks were related to the polar components and determine if possible what some of the more predominate and repetitive peaks were. This would require mass spectral and GC data on the same sample with relative retention times of the exhaust peaks compared to known mixtures of polar components identified by MS results.

Exhaust condensate from two types of naturally aspirated engines, the Cummins NH-220, a four-cycle and the GM Detroit Diesel 6V-71E, a two-cycle, were obtained for study. GC results of the four samples, listed as follows, are shown on Figures 72 and 73. All runs are at 100:1 dilution with the four-cycle on No. 2 and the two-cycle on No. 1 fuel.

Sample	Condition	Operating Condition	Odor Evaluation
GC-113-ES	Cummins NH-220	Hot Idle	$D^5\ A^1\ O^1\ B^0\ P^0$
GC-114-ES	Cummins NH-220	1800 rpm, 150 hp	$D^5\ B^1\ O^1\ A^1\ P^0$
GC-116-ES	Bus 677 6V-71E	Hot Idle	$D^6\ B^2\ O^1\ A^1\ P^0$
GC-117-ES	Bus 677 6V-71E	40 mph, 40 hp	$D^7\ B^3\ O^2\ A^1\ P^0$

To relate the presence of the same compounds in different samples, it is desirable to relate the compounds to a reference peak. All peaks in the trace can then be related by relative retention time, provided the same peak is used for reference. By using relative retention times, rather than the absolute retention times, any effects due to minor changes in the oven temperature or carrier gas flow are minimized. During these analyses, it became obvious that occasionally the reference peak for one sample might not be present in the next. To eliminate any possible confusion and to insure that all samples are referenced to the same peak, propanal was selected. Propanal was shown to be present in exhaust condensate samples by mass spectral analysis, is a fairly stable compound, and can be prepared in dilute solutions for subsequent gas chromatographic analysis. Propanal elutes through the column approximately 3 min after injection using the aforementioned operating conditions. Listed on Table 78 are the retention and relative retention times for the up to twelve peaks found in the Figures 72 and 73 traces.

Using the MS data on Table 79 as an indicator of the type components present in the water bottom, dilute aqueous solutions of many of the compounds were prepared and injected into the GLC. The retention times were determined at 150, 170, and 190°C from GC data and the relative retentions calculated as listed on Table 80. From this and many additional experiments described in Reference 12, it was confirmed that the GC traces are indicative of the same polar materials present by MS and that these compounds could be related to dilute pure compounds by means of the relative retention analysis. Also in Reference 3 are results of initial studies of the exhaust odor condensate from a two-cycle powered bus equipped with a catalytic and a stock muffler. These chromatograms showed a distinct difference in every condition in which the catalytic device was effective in reducing odor. Results and GC traces are listed in detail in Reference 12.

One major area of concern was the possibility that the cold trapped exhaust samples would contain sizable quantities of unburned diesel fuel. This fuel, if trapped, transferred, and injected into the chromatograph, could influence the appearance and number of peaks observed such as that mentioned between the four-cycle and two-cycle and the differences in operating conditions, idle, or speed and load (effect of power or fuel injected), or with and without catalytic muffler. The basic philosophy involved in cold trapping is the same as in aqueous trapping; namely, the odor is removed and concentrated in as little H_2O as possible, with practically all hydrocarbons such as fuel or lube oil being automatically separated. By obtaining the GLC sample from the water bottom and piercing the liquid oil film over the water without contamination of the syringe needle or agitating the water bottom, only the water soluble components, representative of the exhaust odor, are obtained.

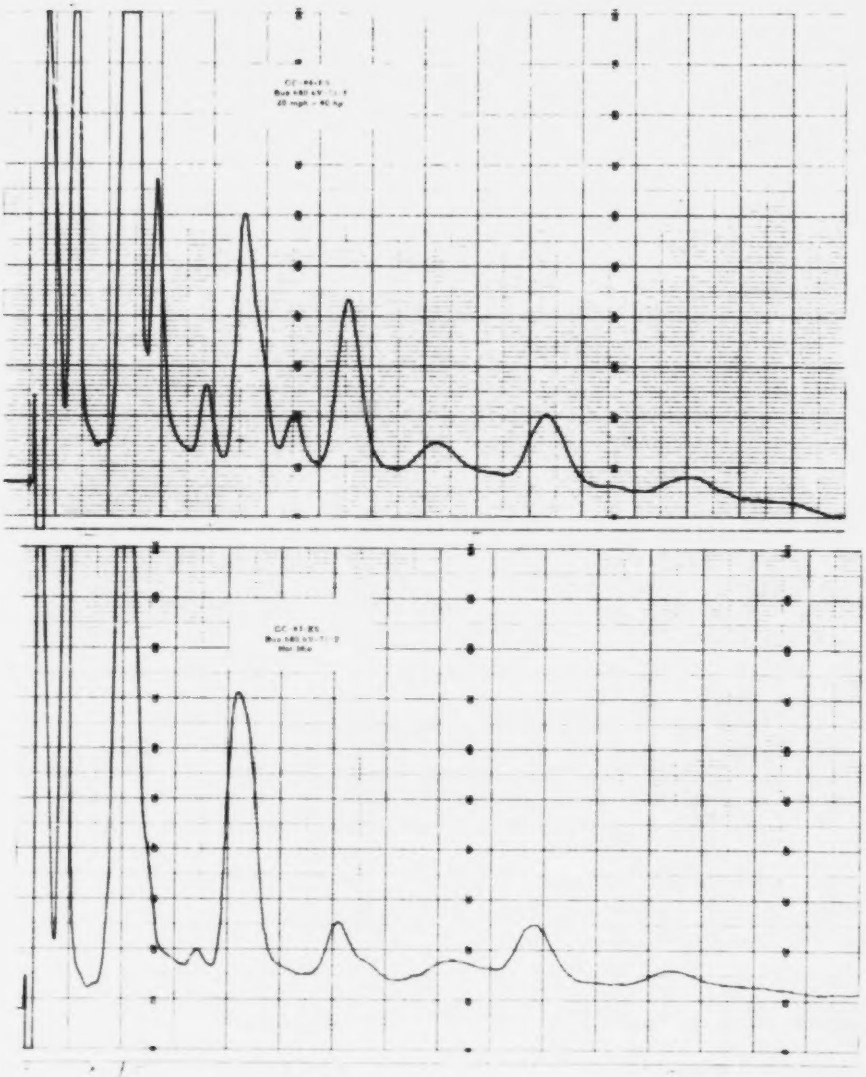


FIGURE 71. GAS CHROMATOGRAM OF BUS 680 6V-71E EXHAUST CONDENSATE AT HOT IDLE AND 40 MPH--40 HP

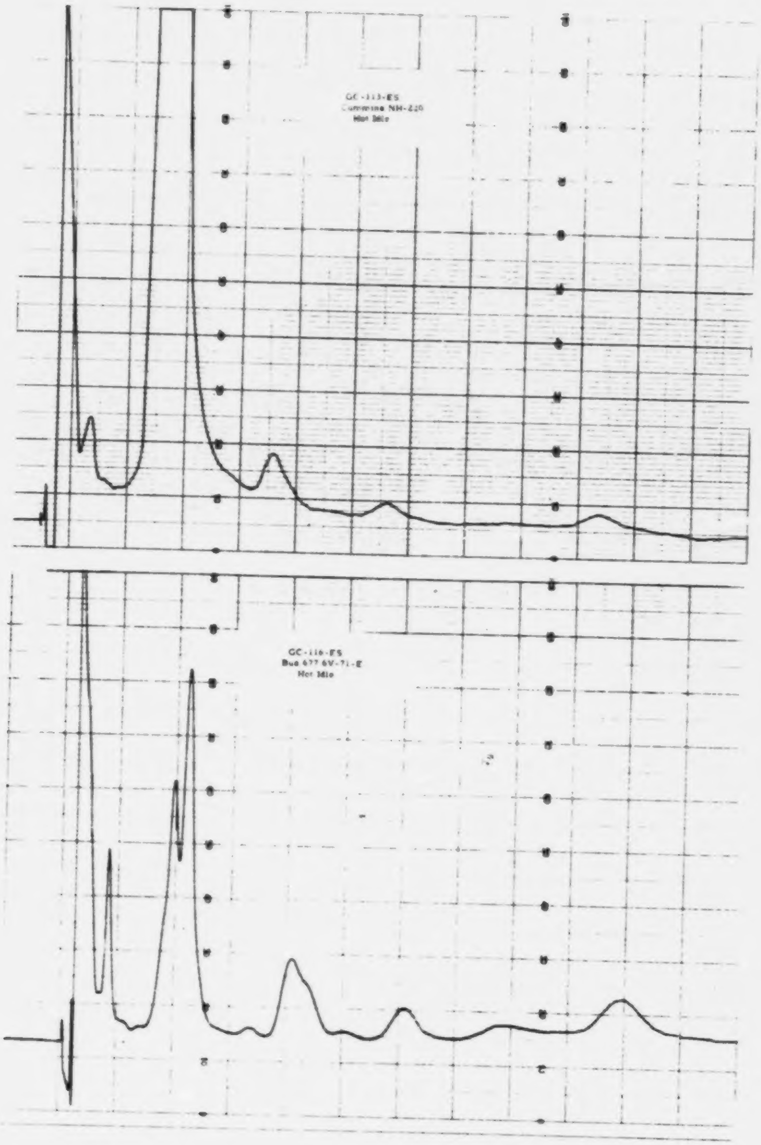


FIGURE 72. GAS CHROMATOGRAM OF CUMMINS NH-220 (FOUR-CYCLE) AND BUS 677 6V-71E (TWO-CYCLE) EXHAUST CONDENSATE AT HOT IDLE

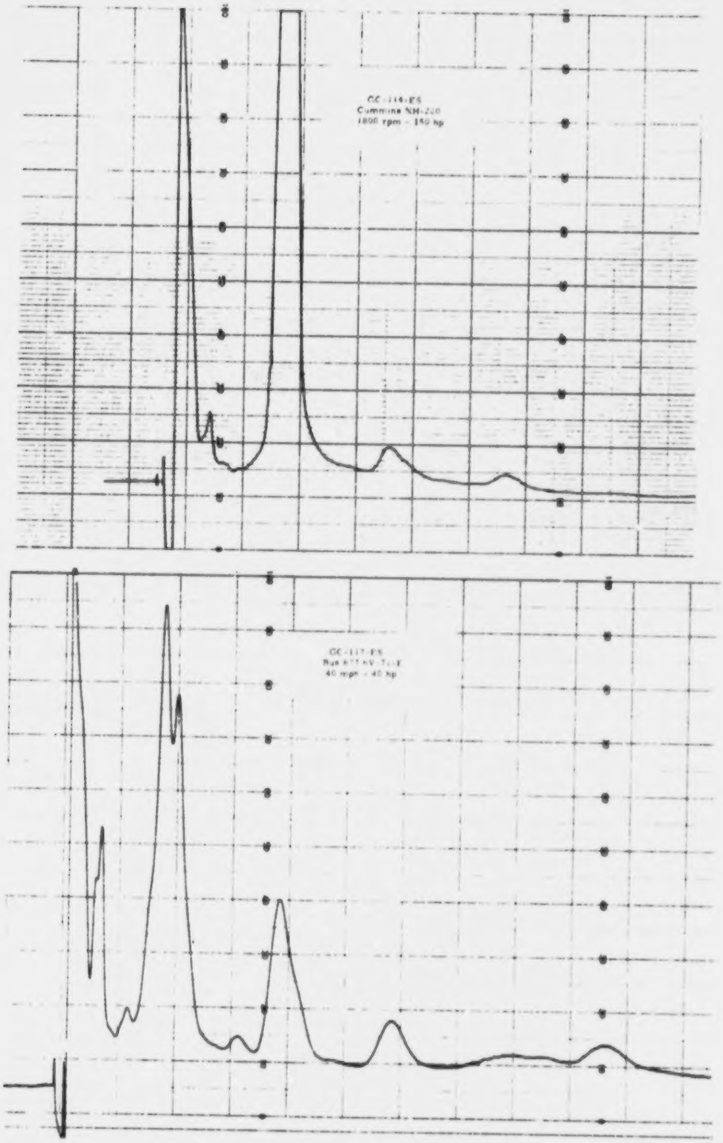


FIGURE 73. GAS CHROMATOGRAM OF CUMMINS NH-220 (FOUR-CYCLE) AND BUS 677 6V-71E (TWO-CYCLE) EXHAUST CONDENSATE AT POWER CONDITIONS

TABLE 78. COMPARATIVE RELATIVE RETENTION RATIOS OF EXHAUST CONDENSATE COMPONENTS OF FOUR-CYCLE AND TWO-CYCLE ENGINES

Peak Number	Cummins NH-220				Bus 677 - 6V-71 E			
	GC-113-ES		GC-114-ES		GC-116-ES		GC-117-ES	
	RT*	RRT†	RT	RRT	RT	RRT	RT	RRT
1	--	--	--	--	--	--	1.60	0.53
2	1.90	0.63	1.86	0.62	2.00	0.67	1.80	0.60
3	2.40	0.80	2.40	0.80	--	--	--	--
4	3.00	1.00	--	--	--	--	2.60	0.93
5	4.30	1.43	--	--	4.30	1.43	4.00	1.33
6	4.60	1.53	4.50	1.50	4.80	1.60	4.60	1.53
7	--	--	--	--	6.90	2.30	6.70	2.23
8	8.20	2.73	8.24	2.75	8.40	2.80	8.10	2.70
9	--	--	--	--	10.40	3.47	--	--
10	12.20	4.07	12.30	4.10	12.40	4.13	12.20	4.07
11	--	--	--	--	15.60	5.20	16.40	5.47
12	19.75	6.58	20.00	6.67	19.90	6.63	19.70	6.57

---

*RT = Retention time, min.

†RRT = Relative retention time: (Propanal = 1.00).

TABLE 79. MASS SPECTRAL ANALYSIS OF EXHAUST CONDENSATE

Component	Exhaust Condensate Samples			
	GC-113-ES	GC-114-ES	GC-116-ES	GC-117-ES
	Four-Cycle Cummins NH-220 Hot Idle $D^5B^0O^1A^1P^0$	Four-Cycle Cummins NH-220 1800 rpm, 150 hp $D^5B^1O^1A^1P^0$	Two-Cycle Bus 677 GM 6V-71 E Hot Idle $D^6B^2O^1A^1P^0$	Two-Cycle Bus 677 GM 6V-71 E 1800 rpm, 150 hp $D^7B^3O^2A^1P^0$
Acetylene	66	58	75	58
Hydrogen Sulfide	24	20	31	21
Carbonyl Sulfide	11	11	14	13
Carbon Disulfide	6	5	3	3
Methyl Mercaptan	13	27	56	88
Sulfur Dioxide	27	42	99	157
Benzene	10	8	11	8
Toluene	4	3	8	4
Propylene	109	65	112	89
Formaldehyde	116	78	292	339
Methyl Acrolein and/or Methyl Vinyl Ketone	19	15	24	18
Methyl Formate	33	30	41	38
Methyl Acetylene	111	69	110	85
Acetaldehyde and/or Ethylene Oxide	132	155	204	125
Methanol	142	83	148	107
Ethanol	12	5	8	7
Butadiene	17	17	29	12
Acrolein and/or Butenes	70	18	58	21
Acetone and/or Propionaldehyde and/or Propylene Oxide	108	53	97	80
Water	Balance	Balance	Balance	Balance

TABLE 80. RETENTION TIMES OF SELECTED COMPOUNDS FOUND IN EXHAUST ODOR CONDENSATE

Compound	Column Temperature					
	150°C		170°C		190°C	
	RT	RRT	RT	RRT	RT	RRT
Formaldehyde	--	--	--	--	--	--
Acetylene	0.55	0.12	0.55	0.18	0.50	0.23
Propylene	1.00	0.21	0.85	0.28	0.80	0.36
Methyl acetylene	1.20	0.25	0.95	0.31	0.75	0.34
Methanol	1.45	0.31	1.15	0.38	1.00	0.45
Methyl vinyl ether	1.50*	0.32	1.25*	0.41	1.42	0.65
Acetaldehyde	1.95	0.41	1.35	0.44	1.10	0.50
Ethylene oxide	2.00	0.42	1.52	0.50	1.20	0.55
1-Butene	2.25	0.47	1.60	0.52	1.33	0.61
Butadiene	2.30	0.48	1.70	0.56	1.35	0.62
Methyl formate	2.55	0.54	1.30	0.43	1.02	0.46
Ethanol	3.55	0.75	2.45	0.80	1.75	0.80
Propylene oxide	4.30	0.90	2.72	0.90	1.15	0.52
Acrolein	4.55	0.96	2.95	0.97	2.10	0.96
Propanal	4.75	1.00	3.05	1.00	2.20	1.00
Acetone	5.50	1.15	3.38	1.12	2.55	1.16
Iso-Butanal	9.90	2.04	5.80	1.90	3.95	1.80
Benzene	12.00	2.51	7.50	2.46	4.60	2.10
Butanal	12.40	2.60	7.20	2.36	4.65	2.12
Methyl vinyl ketone	12.50	2.64	7.00	2.30	4.60	2.10
Crotonaldehyde	19.80	4.17	10.40	3.41	6.80	3.10
Toluene	--	--	17.0	3.50	9.40	4.28

*Propanal = 1.00.

To investigate whether the undesired hydrocarbons were being trapped and analyzed by the GLC system, both "light" and "heavy" materials were studied. Calibration gases of light hydrocarbons in nitrogen were placed into the usual Tedlar sampling bags and sampled according to the aforementioned trapping technique. The resulting condensate was injected into the gas chromatograph (C_1-C_2), and results indicated that these gases were not trapped. Next, pure gaseous samples of the olefins identified by mass spectral analysis were bubbled through 10 ml of distilled water for 5 min, and the resulting solutions were analyzed by gas chromatography. No significant peaks were observed due to the hydrocarbons in the condensate. This was found to be true of all the olefins analyzed.

EM-70-A, the No. 1 kerosene type diesel fuel utilized in most of the bus studies, was used to determine any possible interferences. A fuel-saturated air sample was obtained by bubbling air through the fuel and sampling the head gas above the bubblers. Approximately 0.4 cu ft of air was sampled through the cold trap. The condensate was transferred to a sample bottle and injected into the gas chromatograph. The condensate indicated that no fuel components were detected in the sample.

To demonstrate the repeatability and operability of the technique, approximately seventy-five odor samples were taken, trapped, and analyzed. Buses were routinely sampled, simultaneously with odor and chemistry evaluation, with and without catalytic mufflers, etc. A few vehicles such as intercity truck-tractors powered by two- and four-cycle engines were likewise sampled and the odor condensate analyzed by GC. In the case of the two-cycle powered municipal buses under fleet test of an exhaust catalytic device, the system continued to give the characteristic number and size and shape peaks earlier found for the three cruise and single hot idle conditions.

With satisfactory repeatability and overall operability of the GC system, the final step was to investigate available methods for expressing the GC output in a form that could be used by the computer for statistical analysis. Several methods were investigated and included the following:

- Disc Integration
- Electronic Integration
- "Cut and Weigh" (or Area Integration).

Previous gas chromatograph studies using disc and electronic integrator methods indicate that these methods were unsatisfactory using the present analysis system. First, the disc integrator was found to be unsatisfactory because a baseline separation is not obtained for most of the peaks. Also, due to the wide range of peak shapes (i.e., very sharp to extremely broad), the electronic integrator was found to have serious drawbacks in this particular application. Occasionally, the integrator would not automatically cut off after a broad peak had eluted, even at maximum slope sensitivity settings. Consequently, the only remaining technique available was the cut and weigh method. Instead of integrating areas, the chromatogram was cut into individual peaks, and these were weighed by an electronic balance. This method seemed the most foolproof and acceptable method of interpretation of the GLC trace and preparing the GLC data in a form for use by computer.

C. Preliminary Correlation Results

The preliminary correlation involved two vehicles, a two-cycle powered municipal bus (Bus No. 683 Detroit Diesel 6V-71 E, two-valve, 60S injectors) and a four-cycle, stationary operated engine (Cummins NH-220, six-cylinder naturally aspirated). It was felt that for the instrumental method to be attractive, it should correlate with the panel responses regardless of operating condition such as speed and load, fuel used, type of engine; etc. For purposes of the preliminary study, however, it was felt that the operating conditions, a hot idle and three speed conditions at about 2/3 power level should be conducted with a single fuel, EM-29-F, a No. 2 fuel. The cruise engine speeds were matched such that they represented the end points and the median of the normal operating speed range of the engine in their respective city bus-intercity truck application.

A summary of the odor and chemistry results is included in Tables 81 and 82 of this report. The U_s statistic indicates that differences between engines were statistically valid and, in most cases, could be judged to be significant. The individual run results and odor panel response distribution are contained in Appendix F. A typical GC trace for each engine and condition is shown in Figures 74 through 77. Considering these traces along with the odor panel data, it seems that when a difference in odor existed such as the three cruise conditions, the trace indicated this by more and larger peaks. When there was little odor difference, this was noted also by similar traces.

A stepwise multiple linear regression analysis was then conducted using the CDC 3600 digital computer. Without going into detail (see Reference 3) of the UCLA program used, the multiple linear regression identified the independent variable which permits the best fit for a particular dependent variable. This independent variable was then introduced into the regression analysis equation from which the regression coefficients were computed. From this, the best one independent variable model equation was established. Then, the second best independent variable was identified and introduced into the equation and new regression coefficients were computed. This procedure was continued, stepwise, until all variables were introduced unless the F statistic became meaningless, at which time the stepwise procedure stopped. The general regression analysis expression was of the form:

$$Y = a_0 + a_1X_1 + a_2X_2 \ . \ . \ . \ + a_nX_n$$

where

Y - the dependent variable, one of the twelve variables of interest and, for purposes of this analysis, limited to "D," "B," "O," "A," or "P"

a - a regression coefficient

X - the data point value on "as-measured" basis and not log transformed

n - at most, the number of independent variables (limited to 22 in this study).

The end objective of the multiple linear regression analysis was to determine how well the regression or prediction fits the data and to identify relationships between the various odor qualities "D," "B," "O," "A," and "P," and the exhaust emissions and GLC results.

The variables were numbered as shown in Table 83 and the computed mean and standard deviations are listed. Data for 32 runs, 16 two-cycle and 16 four-cycle, were used as input. Each panel response variable was then related to those independent variables using the criteria of highest

TABLE 81. COMPARISON OF ODOR PANEL RESPONSES FOR CUMMINS NH-220 ENGINE AND DETROIT DIESEL 6V-71 ENGINE

(Correlation Study, 100:1 Dilution)

Date: January 28 and 29, 1969

Fuel: EM-29-F (No. 2 Diesel)

Operating Conditions	Engine	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent	GC Sample
20 mph at 40 hp	6V-71	6.5	2.1	1.9	1.3	1.0	266-ES
125 hp at 1500 rpm	NH-220	3.5	1.0	0.9	0.8	1.4	270-ES
	Net Change	-3.0	-1.1	-1.0	-0.5	+0.4	
	U_s Statistic	0	0	0	0	0	
30 mph at 40 hp	6V-71	5.9	1.8	1.6	1.3	0.9	263-ES
125 hp at 1800 rpm	NH-220	3.7	1.0	1.0	0.8	0.6	271-ES
	Net Change	-2.2	-0.8	-0.6	-0.5	-0.3	
	U_s Statistic	0	0	0	0	1	
40 mph at 40 hp	6V-71	6.2	1.9	1.8	1.4	1.0	264-ES
125 hp at 2100 rpm	NH-220	4.5	1.3	1.0	0.9	0.7	276-ES
	Net Change	-1.7	-0.6	-0.8	-0.5	-0.3	
	U_s Change	0	0	0	0	0.5	
Idle	6V-71	5.9	1.9	1.5	1.3	1.1	265-ES
	NH-220	5.4	1.7	1.2	1.1	0.9	273-ES
	Net Change	-0.5	-0.2	-0.3	-0.2	-0.2	
	U_s Statistic	0.5	*	*	0.5	2	

---

*U_s statistic greater than 2, no statistical difference apparent.

TABLE 82. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS AND U_s STATISTICAL ANALYSIS CUMMINS NH-220 ENGINE AND DETROIT DIESEL 6V-71 ENGINE

(Correlation Study)

Date: January 28 and 29, 1969

Operating Conditions	Engine	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
20 mph 40 hp	6V-71	1633	4.1	1879	5	13	7	776	821
1500 rpm	NH-220	1390	5.4	60	2	20	7	892	1021
125 hp	Net Change	-243	+1.3	-1819	-3	+7	0	+116	+199
	U_s Statistic	2	0	0	0	2	*	0.5	0
30 mph 40 hp	6V-71	305	3.9	1787	3	13	4	782	846
1800 rpm	NH-220	1019	5.1	95	2	19	4	704	735
125 hp	Net Change	+714	+1.2	-1692	-1	+6	0	078	-91
	U_s Statistic	0	0	0	0	1	*	*	0
40 mph 40 hp	6V-71	235	3.7	1641	2	13	5	698	763
2100 rpm	NH-220	1040	6.1	81	2	21	7	502	585
125 hp	Net Change	+805	+2.4	-1560	0	+8	+2	-196	-178
	U_s Statistic	0	0	0	*	0	*	0	0
Idle	6V-71	304	0.9	578	4	19	8	242	243
	NH-220	200	0.8	116	2	21	7	127	224
	Net Change	-104	-0.1	-462	-2	+2	-1	-115	-19
	U_s Statistic	0	*	0	0	*	*	0	*

---

*U_s statistic greater than 2, no statistical difference apparent.

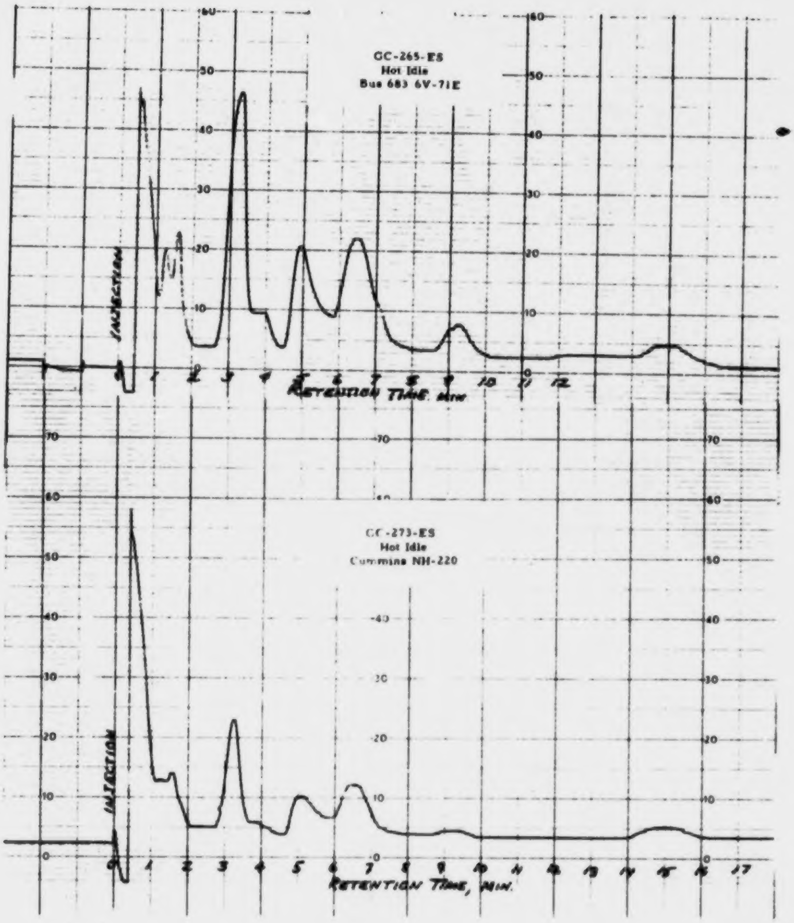


FIGURE 74. GAS CHROMATOGRAMS OF BUS 683 6V-71 E AND CUMMINS NH-220 EXHAUST CONDENSATE AT HOT IDLE

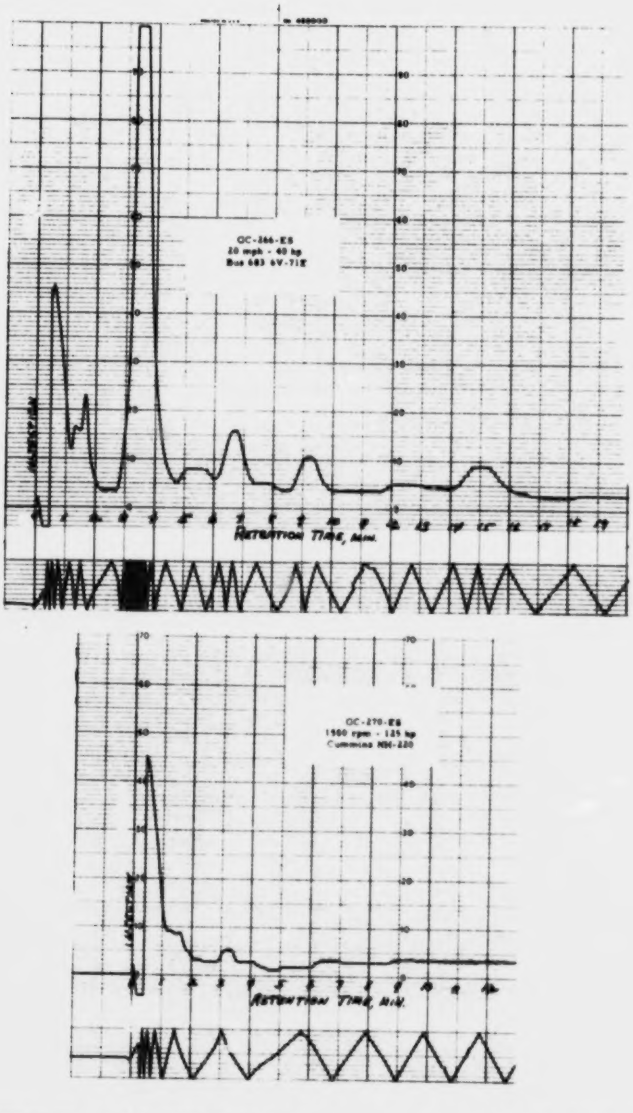


FIGURE 75. GAS CHROMATOGRAMS OF BUS 683 6V-71 E AND CUMMINS NH-220 EXHAUST CONDENSATE AT 20 MPH--40 HP AND 1500 RPM--125 HP, RESPECTIVELY

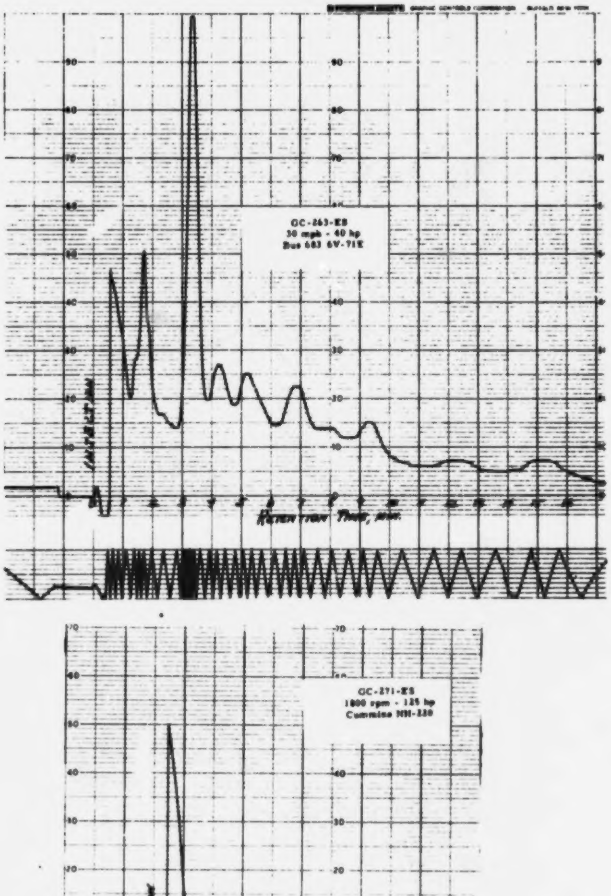


FIGURE 76. GAS CHROMATOGRAMS OF BUS 683 6V-71 E AND CUMMINS NH-220 EXHAUST CONDENSATE AT 30 MPH--40 HP AND 1800 RPM--125 HP, RESPECTIVELY

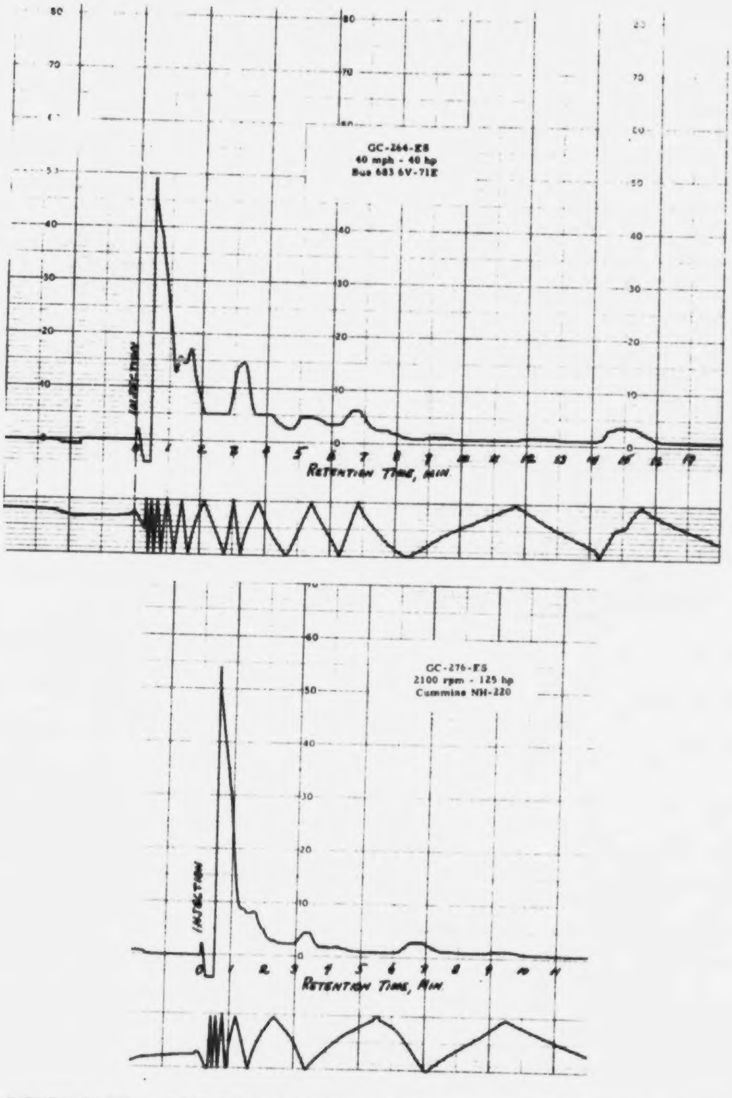


FIGURE 77. GAS CHROMATOGRAMS OF BUS 683 6V-71 E AND CUMMINS NH-220 EXHAUST CONDENSATE AT 40 MPH-- 40 HP AND 2100 RPM--125 HP, RESPECTIVELY

TABLE 83. STATISTICAL CORRELATION STUDY OF DIESEL ODOR AND EMISSIONS LIST OF VARIABLES, THEIR MEAN AND STANDARD DEVIATION

Variable Number	Independent Variable	Mean	Standard Deviation
1	"D" Diesel composite, 1-12	5.20000	1.16647
2	"B" Burnt-Smoky, 1-4	1.59062	0.42530
3	"O" Oily, 1-4	1.36250	0.39411
4	"A" Aromatic-Aldehydic, 1-4	1.09375	0.28391
5	"P" Pungent, 1-4	0.80000	0.27824
6	Total hydrocarbons, ppm C	779.53125	797.80400
7	Carbon monoxide, ppm	765.62500	551.56924
8	Oxides of nitrogen, NO + NO_2 as ppm NO_2	590.87500	268.86509
9	Nitric oxide, ppm	654.53125	275.25167
10	Acrolein, ppm	3.18750	1.40132
11	Formaldehyde, ppm	6.62500	1.89652
12	Aliphatic aldehydes as ppm formaldehyde	17.84375	4.54447
13	Sulfur dioxide, ppm	0.25156	0.08470
14	Carbon dioxide, %	3.72187	1.87973
15	GLC peak 1, units	0.00114	0.00162
16	GLC peak 2, units	0.00381	0.00534
17	GLC peak 3, units	0.03379	0.05489
18	GLC peak 4, units	0.00097	0.00197
19	GLC peak 5, units	0.00461	0.00591
20	GLC peak 6, units	0.00758	0.00733
21	GLC peak 7, units	0.00280	0.00361
22	GLC peak 8, units	0.00032	0.00128
23	GLC peak 9, units	0.00360	0.00430

multiple R value and low standard error of estimation. The independent variables, thus identified, resulted in regression equations for "D," "B," "O," "A," and "P" as follows:

$$\text{"D"} = 4.99 + 0.00142X_6 - 0.00235X_9 + 0.09657X_{11} + \ldots$$

$$\text{"B"} = 1.47 + 0.00052X_6 - 0.00092X_8 + 0.03876X_{11} + \ldots$$

$$\text{"O"} = 1.18 + 0.00049X_6 - 0.00033X_9 - 1.02516X_{17} + 16.3296X_{19} - 67.7384X_{22} + \ldots$$

$$\text{"A"} = 1.12 + 0.00035X_6 - 0.00051X_8 - 42.9638X_{18} + 9.7342X_{19} + \ldots$$

$$\text{"P"} = 1.02 + 0.00034X_6 - 0.00068X_9 - 10.3868X_{16} + \ldots$$

Total hydrocarbons (X_6) were consistently identified as the most important indicator in all five of the above equations indicating excellent ability to correlate with the panel responses. Either oxides of nitrogen (X_8) and nitric oxide (X_9) appear in all five expressions and also correlate well with odor response. It should be noted that X_8 (NO_x) and X_9 (NO) were highly correlated to one another (correlation coefficient = 0.96). Because of their similarity, either one could be used to help predict the odor ratings. Formaldehyde (X_{11}) appeared as the third most important independent variable in the "D" and "B" expressions. Some of the GLC input, variables X_{15} through X_{23} were identified as correlatable.

Another analysis of the data was made in which only the odor and GLC data, no other exhaust emissions, entered into computation. The results were not significant with the exception of the "O" response. The resulting "O" regression equation was:

$$\text{"O"} = 1.06 + 114.949X_{16} - 5.904X_{17} - 121.306X_{18} + 92.962X_{21} - 263.595X_{22} + \ldots$$

D. Procedure Refinement

Though the correlation of GLC to odor panel was less than satisfactory, partial success was evident. The form in which the data are given the computer may be one of the reasons for the general lack of a statistical correlation even though visual inspection of the traces shows an unmistakable relationship. Accordingly, a thorough review of the system was made during which sampling repeatability was reexamined from the standpoint of obtaining the same amount of condensate each time.

Using exhaust from a bus equipped with a stock and a catalytic muffler, replicate condensate samples were obtained. The glass traps were weighed before and after the trapping period and weights for these samples are shown in Table 84.

TABLE 84. EXHAUST CONDENSATE SAMPLE RECOVERY DATA

Sampling Parameter	Sample Weight, gm	Approximate Recovered Volume, ml	Muffler
Individual bags	0.1388	<0.1	Catalytic
Individual bags	0.1952	0.1	Catalytic
Individual bags	0.1622	0.1	Catalytic
Individual bags	0.1236	0.1	Catalytic
Individual bags	0.2166	0.1	Stock
Individual bags	0.3756	0.2	Stock
Individual bags	0.3222	0.2	Stock
Individual bags	0.1747	0.1	Stock
One large bag	0.2228	0.2	Stock
One large bag	0.4173	0.2	Stock
One large bag	0.3957	0.2	Stock
One large bag	0.3003	0.2	Stock
One large bag*	0.1040	trace	Stock
One large bag*	0.1028	trace	Stock
One large bag*	0.1135	trace	Stock

---

*Stored overnight before trapping.

For the hot idle condition with catalytic muffler using individual sampling bags, there was a maximum difference of 70 mg in the four samples, or a standard deviation of 23.7 mg. These samples were transferred from the low temperature cold traps to glass sample vials with a recovered sample volume of approximately 0.1 ml. This indicates a 20- to 80-percent loss in sample transfer attributed to water particles adhering to the surface of the collecting trap. Using the present sampling technique, the moisture in the exhaust freezes on the cold surfaces of the trap and, consequently, when the trap is removed from the -76°C bath, the crystals begin to melt and most migrate through gravity effects to the bottom of the trap. However, there is a considerable amount of condensation which remains on the surface of the trap and, using the syringe as the transferring media, this part of the sample cannot be transferred. With the present sampling technique, this is an unavoidable loss; however, it should be noted that even with this loss, the recovered volume for gas chromatograph analysis generally exceeds 0.1 ml, which is more than enough sample for analysis.

Figures 78 and 79 illustrate the hot idle replicate runs made on one day with the catalytic muffler (Figure 78) and on the next day with stock muffler (Figure 79) using individual bag samples. These chromatograms indicate that the same basic peaks are present in all four samples, however, to a variable degree of intensity. The variation in condensate weights and GC peak weights suggested that one refinement would be to normalize each condensate weight to correct for possible recovered weight differences. The samples with less weight have generally produced GC peaks of greater intensity than samples of corresponding "D" ratings with higher weights, which could be a function of the moisture in the exhaust.

A large Tedlar bag was constructed with four outlets so that simultaneous traps of the same idle exhaust could be made. This was done immediately after exhaust sampling and after overnight storage. Overnight storage decreased the condensate weight appreciably as indicated on Table 84. GC traces, included as Figures 1 to 3 in Appendix F, showed that the same peaks were found and, surprisingly,

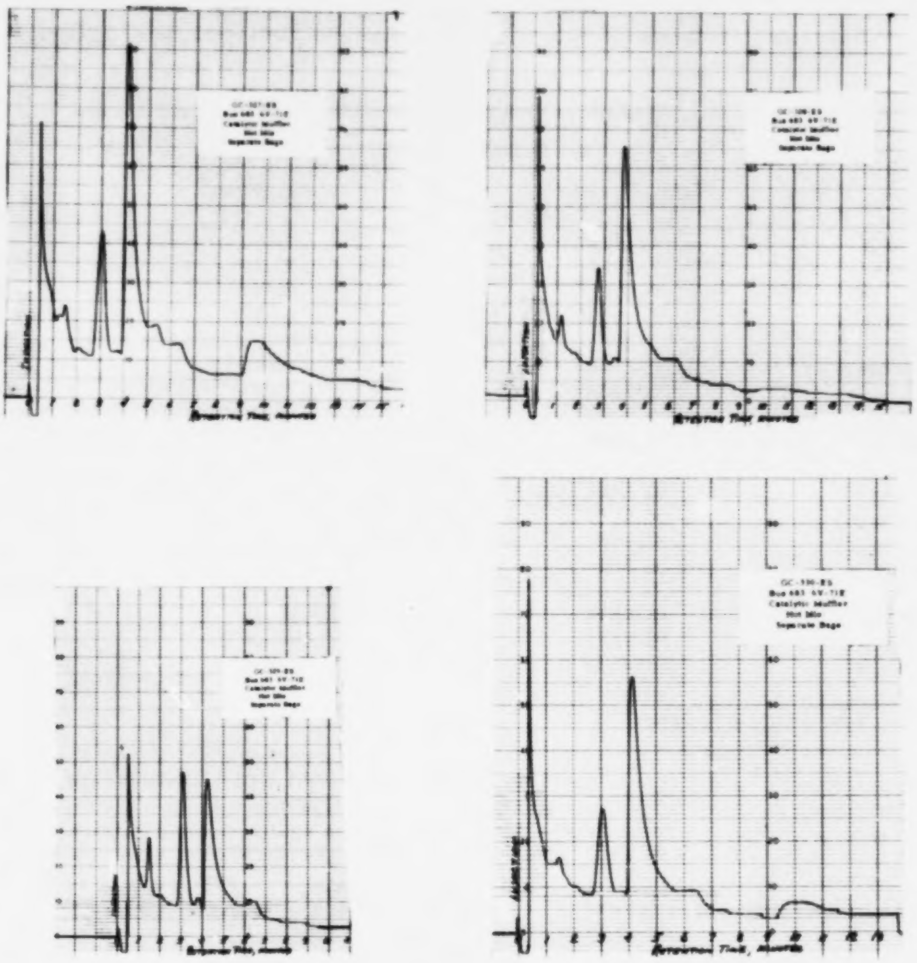


FIGURE 78. GAS CHROMATOGRAMS OF BUS 683 6V-71 E EXHAUST CONDENSATE AT HOT IDLE (CATALYTIC MUFFLER)--TRAPPED FROM INDIVIDUAL BAGS

the peak heights and weights were almost the same. Further study will be required to reconcile the loss in condensate weight by overnight storage of the raw exhaust gas.

E. Eleven-Vehicle Correlation Study

Upon completion of procedure refinements, an eleven-vehicle correlation study was initiated. During this study, the only operating variable which remained constant was the dilution ratio of 100:1 of the odor presented to the panel. No. 1 fuel (EM-70-F) was used with city buses and No. 2 fuel (EM-90-F) was used with truck-tractors. Four operating conditions for each vehicle were selected such that they were representative of the normal operation of the vehicle. The vehicles employed in this study along with engine descriptions are shown in Table 85. The instrumental and wet chemistry results are shown in Table 86 while the odor intensity ratings are shown in Table 87. Each vehicle had

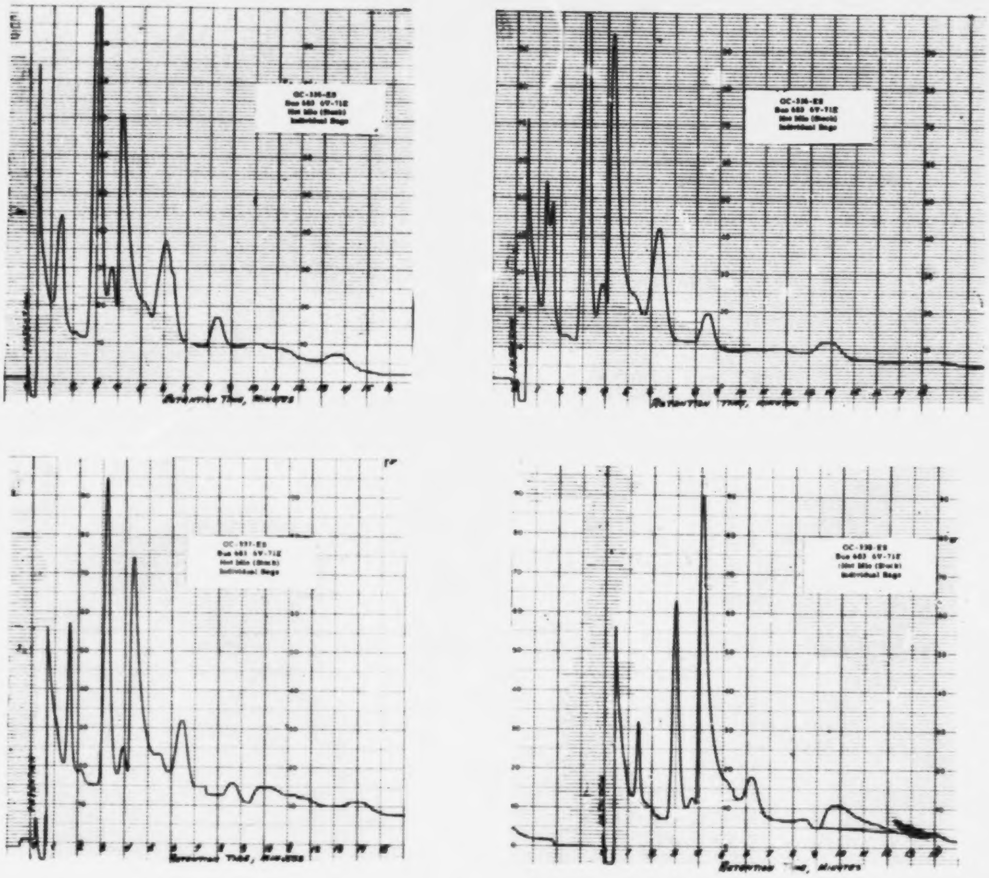


FIGURE 79. GAS CHROMATOGRAMS OF BUS 683 6V-71 E EXHAUST CONDENSATE AT HOT IDLE (STOCK MUFFLER)-- TRAPPED FROM INDIVIDUAL BAGS

four conditions and with the duplicate analysis, eight bag samples were obtained for each vehicle. After trapping these bag samples using the previously described technique, each sample was injected into the gas chromatograph twice. In this manner, for each condition four sets of data were available for computer correlations. All other data, including the instrumental and wet chemistry, were obtained in quadruplicate simultaneously with odor ratings.

Typical gas chromatograph traces for each of the four conditions with the eleven vehicles are shown in the appendix. The visual correlation of peak intensity with odor intensity was observed to be more prevalent in some cases than in others. The identification of the GLC peaks was not included in the original scope of work with the correlation study, although limited effort was made to verify that the peaks were present in several of the exhaust samples as analyzed by mass spectral analysis.

It was decided to normalize the gas chromatograph peaks (both peak weights and peak heights) based on the recovered sample weights of the exhaust condensate. The peak weights are expressed in milligrams. It was felt that the change in the ambient humidity and/or the water formed in the exhaust was a major factor in determining the concentration of the polar compounds in exhaust. If a given

TABLE 85. DESCRIPTION OF THE ELEVEN ENGINES/VEHICLES USED IN CORRELATION STUDY

Engine-Vehicle	Date Tested	Description
A	4/30/69	Bus 677 Powered by 6V-71 E Detroit Diesel Equipped with New 60N Injectors
B	5/28/69	Bus 681 Powered by 6V-71 E Detroit Diesel Equipped with 60S Injectors (Used)
C	6/16/69	Cummins NH-220 four-cycle Engine Operated on Stationary Dynamometer
D	6/24/69	1969 IHC Tractor Powered by Detroit Diesel 8V-71 N Engine 60N Injectors
E	7/1/69	Bus 598 1969 Motor Coach Industries Powered by Detroit Diesel 8V-71 N (60N Injectors)
F	7/8/69	Bus 594 1969 Motor Coach Industries Powered by Detroit Diesel 8V-71 N (60N Injectors)
G	7/15/69	Bus 596 1969 Motor Coach Industries Powered by Detroit Diesel 8V-71 N (60N Injectors)
H	7/23/69	1968 Ford Single-Axle Tractor Powered by Cummins NH-250 Derated to 225 hp at 2100 rpm
I	7/29/69	Bus 681 Powered by 6V-71 E Detroit Diesel Engine Equipped with Low-Sac (Improved 60N) Injectors
J	7/30/69	Bus 681 Powered by 6V-71 E Detroit Diesel Engine Equipped with Used 60S Injectors
K	8/6/69	1965 Drag Axle White Freightliner Tractor Powered by Cummins NH-220 Engine

TABLE 86. OVERALL SUMMARY OF EMISSIONS MEASUREMENTS FOR ELEVEN-VEHICLE CORRELATION

(As-Measured)

Engine/Vehicle	Date Tested	Fuel Code	Engine/Vehicle Condition	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
A	4/30/69	EM-70-F	20 mph/40 hp	565	4.2	544	2	20	4	1043	1090	35
			30 mph/40 hp	156	3.3	427	2	19	6	881	870	34
			40 mph/40 hp	133	3.2	499	2	20	8	835	754	33
			Idle	270	0.9	354	3	30	4	266	258	40
B	5/28/69	EM-70-F	20 mph/40 hp	970	5.6	1265	5	33	11	872	808	54
			30 mph/40 hp	255	4.6	1061	4	18	7	705	630	55
			40 mph/40 hp	211	4.4	864	3	21	10	633	570	49
			Idle	235	1.2	505	4	18	7	231	201	57
C	6/16/69	EM-90-F	1500 rpm/125 hp	2726	9.0	93	5	34	16	1134	1190	34
			1800 rpm/125 hp	1702	7.9	116	6	36	18	897	865	34
			2100 rpm/125 hp	1464	7.6	139	6	40	19	687	640	33
			Idle	220	1.1	139	4	35	15	150	132	24
D	6/24/69	EM-90-F	1500 rpm/180 hp	1780	7.2	240	3	19	6	1362	1282	56
			1800 rpm/180 hp	585	7.0	248	3	16	7	1270	1325	51
			2100 rpm/180 hp	510	6.5	220	2	17	5	967	1136	51
			Idle	77	0.9	197	2	16	4	231	305	40
E	7/1/69	EM-90-F	20 mph/65 hp	116	3.7	385	3	13	4	846	727	--
			25 mph/65 hp	115	3.9	388	3	13	3	771	710	--
			30 mph/65 hp	122	3.9	385	3	13	4	736	632	--
			Idle	140	1.0	435	3	16	6	251	255	--
F	7/8/69	EM-90-F	20 mph/65 hp	150	4.1	197	4	16	3	779	670	--
			25 mph/65 hp	153	4.2	217	4	14	4	771	632	--
			30 mph/65 hp	161	4.1	209	4	16	4	690	630	--
			Idle	176	1.2	287	4	18	5	234	235	--
G	7/15/69	EM-70-F	20 mph/65 hp	156	3.9	586	4	12	6	930	800	--
			25 mph/65 hp	160	4.1	615	4	12	6	907	764	--
			30 mph/65 hp	172	4.3	574	4	12	6	716	725	--
			Idle	197	1.0	429	4	28	9	254	240	--
H	7/23/69	EM-90-F	1500 rpm/150 hp	1765	10.8	64	2	19	8	1562	1200	28
			1800 rpm/150 hp	528	8.8	84	2	20	10	1178	888	25
			2100 rpm/150 hp	537	8.8	116	3	22	9	898	538	25
			Idle	130	1.2	108	2	22	9	119	119	16
I	7/29/69	EM-70-F	20 mph/40 hp	227	5.5	226	2	20	2	1352	1050	--
			30 mph/40 hp	118	4.6	209	2	20	2	1135	856	--
			40 mph/40 hp	98	4.5	171	2	21	3	991	763	--
			Idle	132	1.2	168	2	23	4	396	281	--
J	7/30/69	EM-70-F	20 mph/40 hp	662	5.5	1888	3	30	7	1242	744	--
			30 mph/40 hp	228	4.6	1792	2	27	4	1017	606	--
			40 mph/40 hp	185	4.4	1691	2	26	5	892	569	--
			Idle	212	1.2	809	2	26	6	338	213	--
K	8/6/69	EM-90-F	1500 rpm/150 hp	2000	11.7	203	2	9	3	1508	--	--
			1800 rpm/150 hp	2000	11.4	176	3	9	2	1230	--	--
			2100 rpm/150 hp	1929	10.1	188	3	9	2	910	--	--
			Idle	175	1.3	133	2	11	3	127	--	--

TABLE 87. OVERALL SUMMARY OF ODOR RATINGS FOR ELEVEN-VEHICLE CORRELATION

(100:1 Dilution)

Engine/ Vehicle	Date Tested	Fuel Code	Engine/Vehicle Condition	Average Panel Response				
				"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
A	4/30/69	EM-70-F	20 mph/40 hp	4.2	1.5	1.0	0.8	0.7
			30 mph/40 hp	3.5	1.2	0.9	0.8	0.4
			40 mph/40 hp	3.8	1.1	0.9	0.9	0.6
			Idle	5.0	1.7	1.2	1.2	0.8
B	5/28/69	EM-70-F	20 mph/40 hp	5.0	1.6	1.2	1.1	0.7
			30 mph/40 hp	4.3	1.2	1.1	1.0	0.6
			40 mph/40 hp	4.4	1.3	1.2	1.0	0.6
			Idle	4.9	1.6	1.3	1.1	0.8
C	6/16/69	EM-90-F	1500 rpm/125 hp	4.1	1.2	1.0	0.8	0.4
			1800 rpm/125 hp	3.7	1.2	1.0	0.8	0.2
			2100 rpm/125 hp	4.8	1.6	1.1	0.9	0.4
			Idle	4.8	1.4	1.2	1.0	0.7
D	6/24/69	EM-90-F	1500 rpm/180 hp	4.4	1.3	1.1	1.0	0.8
			1800 rpm/180 hp	3.9	1.2	1.1	1.0	0.6
			2100 rpm/180 hp	3.7	1.1	1.0	0.9	0.5
			Idle	4.3	1.3	1.1	1.0	0.7
E	7/1/69	EM-90-F	20 mph/65 hp	2.3	0.8	0.7	0.7	0.3
			25 mph/65 hp	2.7	0.8	0.7	0.8	0.4
			30 mph/65 hp	2.9	0.8	0.9	0.8	0.2
			Idle	4.1	1.3	1.0	1.0	0.6
F	7/8/69	EM-90-F	20 mph/65 hp	2.4	0.9	0.9	0.8	0.1
			25 mph/65 hp	2.9	0.9	1.0	0.7	0.2
			30 mph/65 hp	3.3	1.0	1.0	0.8	0.4
			Idle	3.6	0.9	1.0	0.9	0.4
G	7/15/69	EM-70-F	20 mph/65 hp	3.4	1.1	1.0	0.9	0.6
			25 mph/65 hp	4.3	1.1	1.1	1.1	0.8
			30 mph/65 hp	4.0	1.1	1.0	1.0	0.8
			Idle	5.1	1.6	1.1	1.2	0.9
H	7/23/69	EM-90-F	1500 rpm/150 hp	3.3	1.1	0.9	0.9	0.4
			1800 rpm/150 hp	3.7	1.2	0.9	0.9	0.7
			2100 rpm/150 hp	3.8	1.4	1.0	0.9	0.5
			Idle	3.8	1.2	1.0	0.9	0.5
I	7/29/69	EM-70-F	20 mph/40 hp	2.9	1.1	1.0	0.9	0.5
			30 mph/40 hp	2.4	0.9	0.9	0.8	0.4
			40 mph/40 hp	2.9	1.0	0.9	0.9	0.4
			Idle	4.0	1.1	1.1	1.1	0.7
J	7/30/69	EM-70-F	20 mph/40 hp	5.3	1.7	1.2	1.1	1.0
			30 mph/40 hp	5.1	1.7	1.3	1.1	1.0
			40 mph/40 hp	5.2	1.7	1.3	1.1	1.0
			Idle	4.6	1.5	1.2	1.1	0.9
K	8/6/69	EM-90-F	1500 rpm/150 hp	4.1	1.3	1.2	1.0	0.8
			1800 rpm/150 hp	3.1	1.1	1.0	0.9	0.5
			2100 rpm/150 hp	4.4	1.3	1.1	0.0	0.9
			Idle	4.9	1.4	1.3	1.0	0.9

weight of polar compounds was recovered in two separate samples that contained different amounts of recovered water, then the observed GLC recorder response for these two samples might be different. It was hoped that normalizing all samples relative to a given recovered sample weight would correct for any change in humidity, or water as a result of combustion. The original GLC data obtained were in terms of peak weight and peak height, and with the corrected peak weights and peak heights, four sets of GLC data were available to correlate with the DBOAP measurements along with instrumental and wet chemical analysis. By running each of the GLC data acquisition methods separately, it was hoped to obtain the best correlation method using the exhaust condensate-GLC technique. The four methods for data acquisition and their respective correlation designations are shown below:

Correlation	Card A	Data Acquisition--2nd Card
AB	Odor, Instrumental, Chemical	GLC-uncorrected peak weights
AC	Odor, Instrumental, Chemical	GLC-corrected peak weights
AD	Odor, Instrumental, Chemical	GLC-uncorrected peak heights
AC	Odor, Instrumental, Chemical	GLC-corrected peak heights

Each sequence, that is, AB, AC, etc., was run as a separate correlation. The results of the eleven-vehicle correlation was somewhat rewarding although the GLC peaks of the polar compounds obtained with the bag trapping technique were not as significant as hoped.

A complete list of variables, their mean and standard deviation are shown in Table 88. The correlation equations for the first six terms (although a considerable number of more terms could be

TABLE 88. STATISTICAL CORRELATION STUDY OF DIESEL ODOR AND EMISSIONS LIST OF VARIABLES, THEIR MEAN AND STANDARD DEVIATION TO SEVERAL CORRELATION METHODS

(Eleven-Vehicle Study)

Variable Number	Independent Variable	Mean for Correlation				Standard Deviation for Correlation			
		AB[1]	AC[2]	AD[3]	AE[4]	AB[1]	AC[2]	AD[3]	AE[4]
1	"D" Diesel composite, 1-12	3.93636	3.93636	3.93636	3.93636	0.93938	0.93938	0.93938	0.93938
2	"B" Burnt smoky 1-4	1.23807	1.23807	1.23807	1.23807	0.30850	0.30850	0.30850	0.30850
3	"O" Oily, 1-4	1.03750	1.03750	1.03750	1.03750	0.18781	0.18781	0.18781	0.18781
4	"A" Aromatic aldehydic, 1-4	0.93295	0.93295	0.93295	0.93295	0.16264	0.16264	0.16264	0.16264
5	"P" Pungent, 1-4	0.59261	0.59261	0.59261	0.59261	0.27651	0.27651	0.27651	0.27651
6	Total hydrocarbons, ppm C	503.97727	503.97727	503.97727	503.97727	497.06119	497.06119	497.06119	497.06119
7	Carbon monoxide, ppm	571.27841	571.27841	571.27841	571.27841	701.73291	701.73291	701.73291	701.73291
8	Oxides of nitrogen, $NO + NO_2$ as ppm NO_2	792.22159	792.22159	792.22159	792.22159	384.67594	384.67594	384.67594	384.367594
9	Nitric oxide, ppm	693.47727	693.47727	693.47727	693.47727	349.36036	349.36036	349.36036	349.36036
10	Acrolein, ppm	2.96591	2.96591	2.96591	2.96591	1.26896	1.26896	1.26896	1.26896
11	Formaldehyde, ppm	6.48295	6.48295	6.48295	6.48295	4.36607	4.36607	4.36607	4.36607
12	Aliphatic aldehydes as ppm formaldehyde	20.55682	20.55682	20.55682	20.55682	7.45632	7.45632	7.45632	7.45632
13	Sulfur dioxide, ppm	2.24545	2.24545	2.24545	2.24545	2.87684	2.87684	2.87684	2.87684
14	Carbon dioxide, %	4.65568	4.65568	4.65568	4.65568	2.81986	2.81986	2.81986	2.81986
15	GLC peak 1	42.13068	21.39773	7.09659	3.68182	65.54466	37.38649	11.95739	6.81770
16	GLC peak 2	78.32386	41.05114	11.26705	5.75000	110.14589	60.68290	15.44843	8.29561
17	GLC peak 3	50.84659	25.57386	7.91477	3.36932	109.52351	67.38169	30.83317	10.32473
18	GLC peak 4	183.73295	127.39205	23.98295	11.26136	252.62791	326.62935	50.04072	17.64863
19	GLC peak 5	199.26136	165.22727	43.26136	20.78977	235.47443	549.22410	155.83779	64.40059
20	GLC peak 6	149.60227	81.19318	16.36932	8.60795	256.90049	145.49571	34.58530	16.30564
21	GLC peak 7	26.33523	13.26705	0.63068	0.33523	96.30319	47.30487	2.71398	1.27217
22	GLC peak 8	110.06250	54.17045	5.41477	2.94318	201.78306	94.79707	8.32234	4.81274
23	GLC peak 9	131.64773	73.88636	6.00000	3.33523	176.67006	109.49541	8.93404	5.04563
24	GLC peak 10	248.77841	131.48295	11.02841	6.02273	346.36196	196.38513	15.59649	9.74472

NOTE:

[1] AB - GLC peaks reported as uncorrected peak weights.
[2] AC - GLC peaks reported as corrected peak weights.
[3] AD - GLC peaks reported as uncorrected peak heights.
[4] AE - GLC peaks reported as corrected peak heights.

included), in order of their indicated importance, are shown in Table 89. As illustrated in Table 89, the most predominate terms in all forms of the correlation techniques were X_6 (hydrocarbons), X_{12} (total aliphatic aldehydes) and X_8 (oxides of nitrogen). Other variables such as nitric oxide, acrolein, and various GLC peaks were observed to appear in several of the correlation equations. Terms involving hydrocarbons and oxides of nitrogen were observed in all equations except the "O" equation for the AC correlation. Total aliphatic aldehydes (X_{12}) was a predominate term for all "D" and "B" equations. To determine the significance of each term in their respective equations, it was desired to determine the individual contribution of each variable to the individual equation.

The most important variable, in order of its indicated importance for the "D" and "B" equations was found to be total aliphatic aldehydes. This was found to be the case for all four of the correlation runs. The relative significance of total aliphatic aldehydes effect can be determined by multiplying the aldehyde constant by the average aldehyde concentration. The value thereby obtained is the contribution of total aliphatic aldehydes to the total odor intensity rating, whether it be "D," "B," "O," "A," or "P." Although total aldehyde term was the most important for the "D" and "B" equations, it had essentially no effect in the remaining "O," "A," and "P" equations for the four correlation runs. The effect of the total aldehyde (as well as other correlated variables) is shown in Table 90. The total aldehyde contribution to the "D" intensity rating was approximately 0.70 as compared to the 0.40 to 0.53 "D" intensity unit contribution of unburned hydrocarbons. Using the four different GLC data sets had only a slight

TABLE 89. CORRELATION EQUATIONS--ELEVEN-VEHICLE STUDY

Correlation AB--Odor, Instrumental, Chemical, and GLC Uncorrected Peak Weights

$$D = 3.48053 + 0.03412X_{12} + 0.00088X_6 - 0.00108X_8 + 0.00054X_7 + 0.00120X_{23} - 0.09923X_{10} + \ldots$$

$$B = 0.93683 + 0.01762X_{12} + 0.00026X_6 + 0.00039X_{23} - 0.04744X_{10} + 0.03337X_{13} - 0.00022X_8 + \ldots$$

$$O = 1.08246 + 0.00013X_6 - 0.00021X_8 + 0.00008X_7 - 0.00028X_{22} + 0.00047X_{15} + 0.00024X_{21} + 0.00007X_{24} + \ldots$$

$$A = 1.00103 + 0.00014X_6 - 0.00019X_8 + 0.00021X_{23} + 0.01696X_{13} - 0.01640X_{10} - 0.00012X_{22} + 0.00018X_{21} + \ldots$$

$$P = 0.72797 + 0.00028X_6 + 0.00041X_{23} - 0.05734X_{10} + 0.00016X_7 - 0.00027X_8 - 0.00021X_{18} + \ldots$$

Correlation AC--Odor, Instrumental, Chemical, and GLC Corrected Peak Weights

$$D = 3.26627 + 0.03407X_{12} + 0.00090X_6 + 0.00279X_{16} - 0.00166X_8 + 0.00029X_7 - 0.00138X_{22} + 0.00090X_9 + \ldots$$

$$B = 0.90914 + 0.01852X_{12} + 0.00017X_6 + 0.00115X_{16} - 0.00041X_{22} - 0.00011X_8 - 0.02635X_{10} + \ldots$$

$$O = 0.89668 + 0.00109X_{16} + 0.00724X_{12} - 0.01256X_{14} + 0.00006X_{19} - 0.00042X_{17} - 0.00042X_{21} + \ldots$$

$$A = 1.01960 + 0.00010X_6 - 0.00017X_8 + 0.01445X_{13} - 0.01741X_{10} - 0.00033X_{21} + 0.00025X_{24} - 0.00024X_{20} + \ldots$$

$$P = 0.72415 + 0.00026X_6 - 0.00012X_{18} + 0.00062X_{16} - 0.00021X_8 - 0.00036X_{22} - 0.04710X_{10} + 0.00010X_7 + \ldots$$

Correlation AD--Odor, Instrumental, Chemical, and GLC Uncorrected Peak Heights

$$D = 3.42662 + 0.03411X_{12} + 0.00106X_6 - 0.00104X_8 + 0.00048X_7 - 0.01660X_{22} - 0.00799X_{24} + \ldots$$

$$B = 1.07322 + 0.01485X_{12} + 0.00024X_6 - 0.04854X_{10} - 0.00022X_8 + 0.00011X_7 - 0.00142X_{17} + \ldots$$

$$O = 1.10486 + 0.00015X_6 - 0.00023X_8 - 0.00008X_7 - 0.00099X_{17} - 0.00387X_{22} + 0.00279X_{15} + \ldots$$

$$A = 1.05099 + 0.00015X_6 - 0.00020X_8 + 0.00277X_{13} - 0.00358X_{22} + 0.00006X_7 - 0.01742X_{10} + \ldots$$

$$P = 0.78266 + 0.00031X_6 - 0.06273X_{10} - 0.00029X_8 + 0.00016X_7 - 0.00734X_{22} + 0.00315X_{23} + \ldots$$

Correlation AE--Odor, Instrumental, Chemical, and GLC Corrected Peak Heights

$$D = 3.52419 + 0.03811X_{12} + 0.00080X_6 - 0.00107X_8 + 0.00047X_7 - 0.01204X_{20} - 0.03082X_{22} + \ldots$$

$$B = 1.01753 + 0.01887X_{12} + 0.00020X_6 - 0.03693X_{10} - 0.00371X_{20} - 0.00784X_{22} - 0.00021X_8 + 0.00010X_7 + \ldots$$

$$O = 1.01676 + 0.00011X_6 - 0.00019X_8 + 0.00009X_7 - 0.00295X_{24} + 0.00676X_{12} - 0.01022X_{11} + 0.00411X_{23} + \ldots$$

$$A = 1.03794 + 0.00010X_6 - 0.00020X_8 - 0.00257X_{24} + 0.00007X_7 - 0.00204X_{20} - 0.01673X_{21} + \ldots$$

$$P = 0.78990 + 0.00025X_6 - 0.01221X_{22} - 0.00372X_{20} - 0.00025X_8 + 0.00013X_7 - 0.04505X_{10} + \ldots$$

TABLE 90. EFFECT OF CORRELATED VARIABLES OF THE DBOAP INTENSITY RATING (BASED ON MEAN VALUES)

Odor Variable	X_6 - Hydrocarbons				X_{12} - Total Aliphatic Aldehydes			
	AB	AC	AD	AE	AB	AC	AD	AE
ΔD	0.44	0.45	0.53	0.40	0.70	0.70	0.70	0.78
ΔB	0.13	0.09	0.12	0.10	0.36	0.38	0.31	0.39
ΔO	0.07	--	0.08	0.06	--	0.15	--	0.14
ΔA	0.07	0.05	0.08	0.05	--	--	--	--
ΔP	0.14	0.13	0.16	0.13	--	--	--	--

Odor Variable	X_8 - Oxides of Nitrogen				X_7 - Carbon Monoxide			
	AB	AC	AD	AE	AB	AC	AD	AE
ΔD	0.86	1.33	0.82	0.85	0.31	0.16	0.27	0.27
ΔB	0.17	0.09	0.17	0.17	--	--	0.06	0.06
ΔO	0.17	--	0.18	0.15	0.05	--	0.05	0.05
ΔA	0.15	0.13	0.16	0.16	--	--	0.03	0.04
ΔP	0.21	0.17	0.23	0.20	0.09	0.06	0.09	0.07

Odor Variable	Acrolein - X_{10}				X_{23} - GLC Peak 9			
	AB	AC	AD	AE	AB	AC	AD	AE
ΔD	0.29	--	--	--	0.15	--	--	--
ΔB	0.14	0.08	0.14	0.11	0.05	--	--	--
ΔO	--	--	--	--	--	--	--	0.01
ΔA	0.04	0.05	0.05	--	0.03	--	--	--
ΔP	0.17	0.14	0.19	0.13	0.05	--	--	--

Odor Variable	X_{13} - Sulfur Dioxide				X_{22} - GLC Peak 8			
	AB	AC	AD	AE	AB	AC	AD	AE
ΔD	--	--	--	--	--	0.07	0.09	0.09
ΔB	0.07	--	--	--	--	0.02	--	0.02
ΔO	--	--	--	--	0.03	--	0.02	--
ΔA	0.04	0.03	0.01	--	0.01	--	0.02	--
ΔP	--	--	--	--	--	0.02	0.04	0.04

Odor Variable	X_{15} - GLC Peak 1				X_{17} - GLC Peak 3			
	AB	AC	AD	AE	AB	AC	AD	AE
ΔD	--	--	--	--	--	--	--	--
ΔB	--	--	--	--	--	--	0.04	--
ΔO	0.02	--	0.02	--	--	0.01	0.03	--
ΔA	--	--	--	--	--	--	--	--
ΔP	--	--	--	--	--	--	--	--

Odor Variable	X_{24} - GLC Peak 24				X_{20} - GLC Peak 6			
	AB	AC	AD	AE	AB	AC	AD	AE
ΔD	--	--	0.09	--	--	--	--	0.10
ΔB	--	--	--	--	--	--	--	0.03
ΔO	0.02	--	--	0.02	--	--	--	--
ΔA	--	0.03	--	0.02	--	0.04	--	0.02
ΔP	--	--	--	--	--	--	--	0.03

effect on changing the effect of aldehydes or unburned hydrocarbons. One of the study objectives was to determine if expression of the GLC results had a significant effect on the correlation coefficients. Generally speaking, correcting the peak heights and weights for the recovered sample weight had no substantial effect in moving the GLC data to a higher level of correlation.

Although total aliphatic aldehydes was the first most important variable for the "D" and "B" equations, unburned hydrocarbons and oxides of nitrogen played an equally important part in the correlation equations. The most important variable for equations other than the "D" and "B" was hydrocarbons, followed by oxides of nitrogen. Unburned hydrocarbons was consistently the predominate indicator of "O," "A," and "P" intensity. Oxides of nitrogen had a relatively high value when the effect of the variable (coefficient X mean value) was determined, see Table 90. Although the values were high, the negative sign before the coefficient indicated that production of more nitrogen oxides will result in a lower odor intensity rating. Similar results were observed with several of the GLC peaks, in that negative signs before coefficient indicate a reduction in the odor intensity.

The correlation of the GLC peaks, when calculated in terms of their relative importance to the overall DBOAP ratings, was somewhat less than desirable. Referring back to Table 90, the most important GLC peaks were peaks 8 and 9. These two variables, X_{22} and X_{23}, were the most important GLC contributions to the odor intensity ratings. Although X_{22} appeared in more of the equations, the overall intensity contribution (coefficient X mean) was strongest for X_{23} (0.15) in the "D" equation using the AB correlation. The intensity contribution of X_{22} for the "D" equations is somewhat less, approximately 0.08. The contribution of the remaining GLC peaks were generally less than 0.05. The contribution of GLC with values this low would not be considered significant nor justify the method.

Since unburned hydrocarbons appeared to be the overall most important variable in the DBOAP correlation equations, it was decided to rerun the AB correlation but using only unburned hydrocarbons as the variable. That is, all other variables (CO, NO_x, etc.) were omitted from the data input and, in this manner, the strength of the unburned hydrocarbons correlation by itself can be compared to the correlation study involving all variables. The "D" equations below illustrate different correlation equations when using selected data input:

From all variables,

$$D = 3.48053 + 0.03412X_{12} + 0.00088X_6 - 0.00108X_8 + 0.00054X_7 + 0.00120X_{23} - 0.09923X_{10}$$

For hydrocarbon only variable,

$$D = 3.93678 + 0.00081X_6$$

The correlation constants, coefficients, standard error and multiple R values, listed in Table 91, indicate that higher constants were found for the "D" and "B" equations when using hydrocarbons only

TABLE 91. CORRELATION COMPARISON WITH ALL VARIABLES AND TOTAL HYDROCARBONS ONLY

(Eleven-Vehicle Study)

Correlation with All Variables

Odor Quality	Constant	X_6 - Coefficient	Standard Error	Multiple R
D	3.48053	0.00088	0.6757	0.7074
B	0.93683	0.00026	0.2375	0.6540
O	1.0825	0.00013	0.1543	0.5933
A	1.00103	0.00014	0.1400	0.5371
P	0.72797	0.00028	0.2196	0.6250

Correlation with Total Hydrocarbons Only (X_6)

Odor Quailty	Constant	X_6 - Coefficient	Standard Error	Multiple R
D	3.52856	0.00081	0.8514	0.4282
B	1.11769	0.00024	0.2856	0.3848
O	0.97454	0.00012	0.1778	0.3306
A	0.88198	0.00010	0.1551	0.3091
P	0.47671	0.00023	0.2525	0.4134

as the variable, while just the opposite was observed when comparing constants for the "O," "A," and "P" equations. The constants, coefficients, etc., for the correlation involving all 23 variables was terminated after the 6th variable in the equation. An equation, determined from all 23 variables, could be presented but the contribution of terms after the 5th or 6th do not significantly improve or lower the standard error of estimate and increase the multiple R value.

The correlation using hydrocarbons as the only variable has only one term beside the constant. Although the constants for the two equations are quite close, so are the coefficients for the X_6 (hydrocarbon) term. However, it should be noted that the standard error of estimate for the correlation with all 23 variables is less. Also, the multiple R values were considerably higher with the "D" and "B" equations when using all 23 variables. The constants for "O," "A," and "P" equations were less with the X_6 correlation than with the correlation involving 23 variables. However, the standard error of estimate and multiple R values still favors the use of the correlation using more variables rather than the single variable, hydrocarbons. It is difficult to plug in the mean values for the measured variables through six terms and justifiably compare to the same correlation using only one term. The expressions for these equations are shown below:

From all variables,

$$D = 3.48053 + 0.03412\,(20.55682) + 0.00088\,(503.97727) - 0.00108\,(792.22159) + 0.00054\,(571.27841) + 0.00120\,(131.64773) - 0.09923\,(2.96591)$$

$$D = 3.94186$$

For hydrocarbon only variable,

$$D = 3.52856 + 0.00081\,(503.97727)$$

$$D = 3.93678$$

Although the overall "D" intensity rating is essentially the same when using both methods, the standard error and multiple R values favor using more variables.

IX. ODOR, SMOKE, AND OTHER EMISSIONS FROM AN INTERCITY COACH

During Parts I and II of this long-range investigation, buses have been of municipal or intracity type. Except for one coach powered by a four-cycle engine, all tests and evaluations have been with a scavenged two-cycle type V-6 engine. Intercity type buses that are used by the large public carriers such as Continental Trailways or Greyhound, etc., generally are powered by larger two-cycle powerplants. The mode of operation includes mostly high speed highway type service with the heavier, higher heat content number 2 diesel fuel similar to a truck-tractor. Motor Coach Industries, part of the Greyhound Corporation, manufacture coaches that are designed for intercity and suburban public transportation and this type of coach was selected for evaluation.

A. Objective

The purpose of this study was to modify current operating procedures and to acquire odor, smoke, and other emissions from a small group of intercity buses.

B. Vehicle Description

Three 1969 Motor Coach Industries Model MC-5A, Challenger, buses powered by Detroit Diesel 8V-71 N two-cycle engines were obtained from the San Antonio Transit System. The engines, with 60N injectors, were rated at 280 hp at 2100 rpm. The driveline consisted of a Dana four-speed manual transmission with a 3.36:1 MCI single-drive rear axle. The three units were identified as follows:

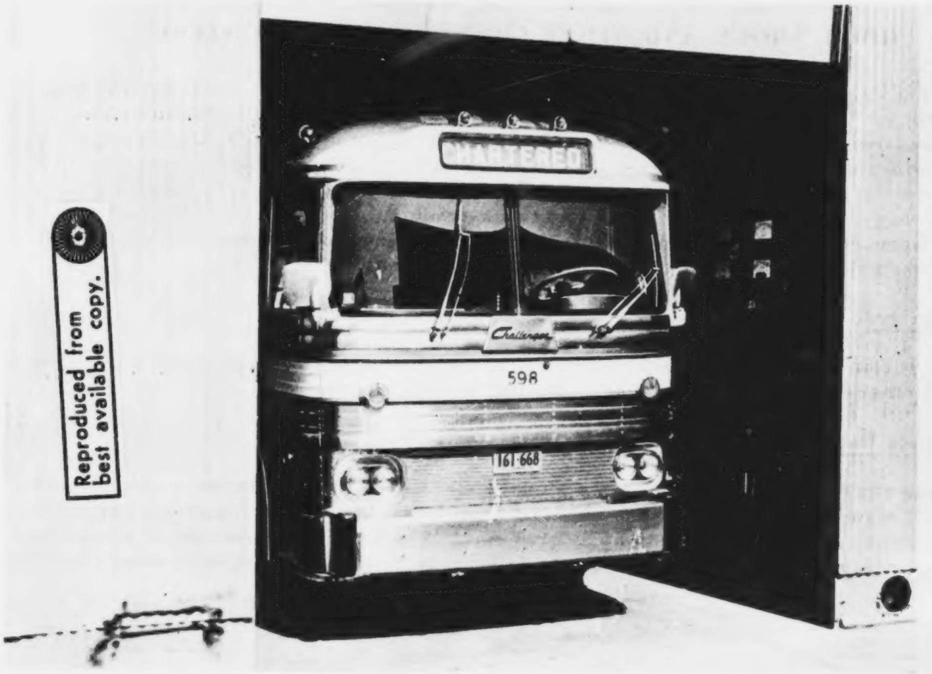
Bus Number	Mileage	Dates Tested
598	30,090	July 1 and 2, 1969
594	11,807	July 8 and 9, 1969
596	1,803	July 15 and 16, 1969

The engines were in new condition and no engine maintenance such as injector check or overhaul had been performed. The coaches were in routine operation on the high-speed expressway and interstate loop type highway under charter and contract. These vehicles were normally fueled with a No. 1 kerosene type fuel as this is the fuel normally used by the San Antonio Transit System. Figures 80 and 81 are front and rear views of Bus 598 prepared for odor and smoke test. The usual horizontal 4-inch exhaust pipe was removed and the exhaust split so that approximately half would travel through the laboratory exhaust system for odor sampling and chemical analysis and the other half directed from the test area (Fig. 81). Figures 82 and 83 are rear and side views of the engine compartment, respectively. The engine is mounted in the same direction as the bus.

C. Results

Six conditions were used for dynamometer operation of the vehicle and odor evaluation by the panel. The six conditions represent a hybrid of the truck and bus operating procedures. The three constant speed conditions were at 1400, 1700, and 2000 rpm at part engine load to represent the normal operating speed range of this engine application. The vehicle was operated in second gear to give 20-, 25-, and 30-mph vehicle speed. The idle condition was similar to a bus in which a cruise at 1700 rpm was followed by the idle. Idle-acceleration and deceleration were basically truck operating procedures in that the idle-accel was in first gear and the deceleration condition was from 2000 rpm in second gear. A 100:1 dilution level of the exhaust was used, similar to other buses as this dilution level reflects the atmospheric dispersion of the exhaust from the horizontal tailpipe equipped bus. For purposes of laboratory evaluation, it was decided to use both a No. 1 (EM-70-F) and No. 2 (EM-90-F) fuel. The odor panel results for the three units are summarized on Table 92 for both fuels. In some instances, the "D" ratings with the No. 1 fuel were higher than with the No. 2 fuel. The "B" ratings were basically the same from one fuel to the other as were the "O," "A," and "P" ratings. Based on previous experience, it was expected the "B" ratings would have been higher with the No. 2 fuel. Considering the variability of the results for the three vehicles, it appears that Bus No. 594 had less overall odor than the other two vehicles with the No. 1 fuel. In general, the odor ratings are similar to other N type two-cycle scavenged engines evaluated at this same dilution level.

On Table 93 are the smoke results obtained under constant speed and transient type conditions. Because the vehicle is equipped with a four-speed manual transmission, the operating conditions were


CHARTERED
Challenger
598
161-668

Reproduced from best available copy.

FIGURE 80. LABORATORY TEST OF AN INTERCITY BUS

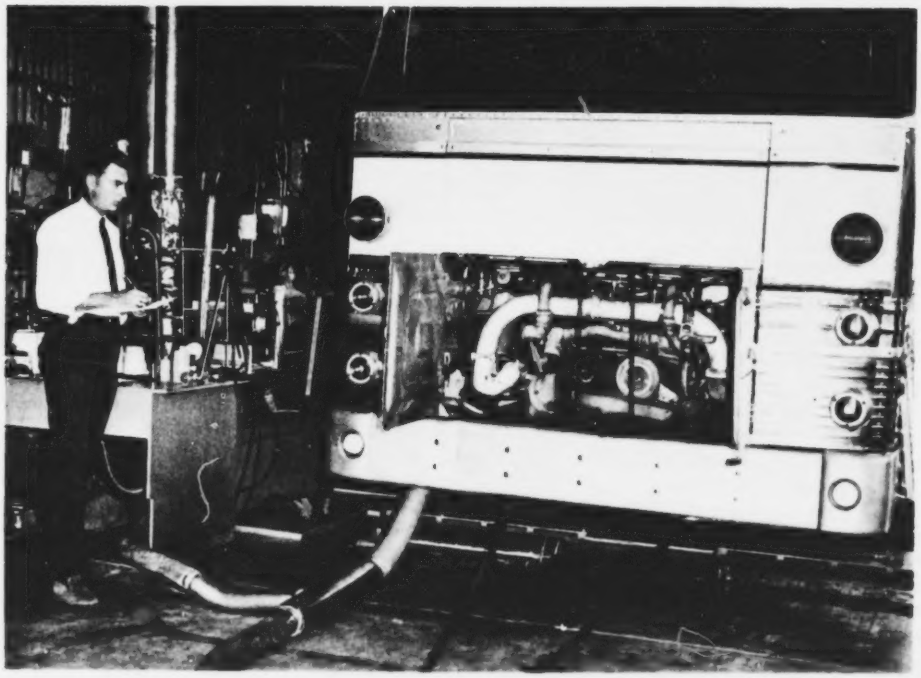


FIGURE 81. INTERCITY BUS PREPARED FOR ODOR AND OTHER EMISSIONS MEASUREMENTS

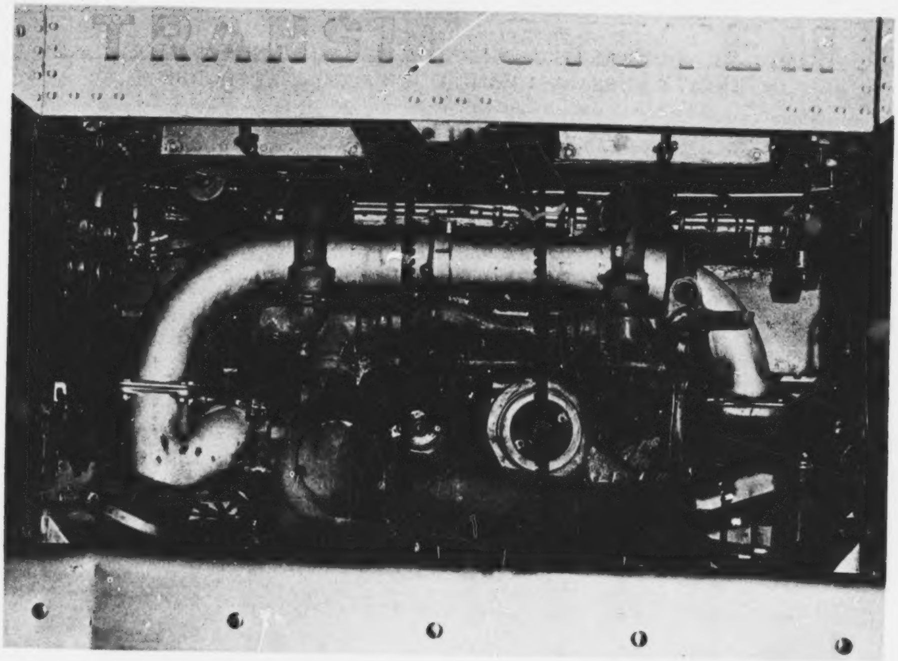
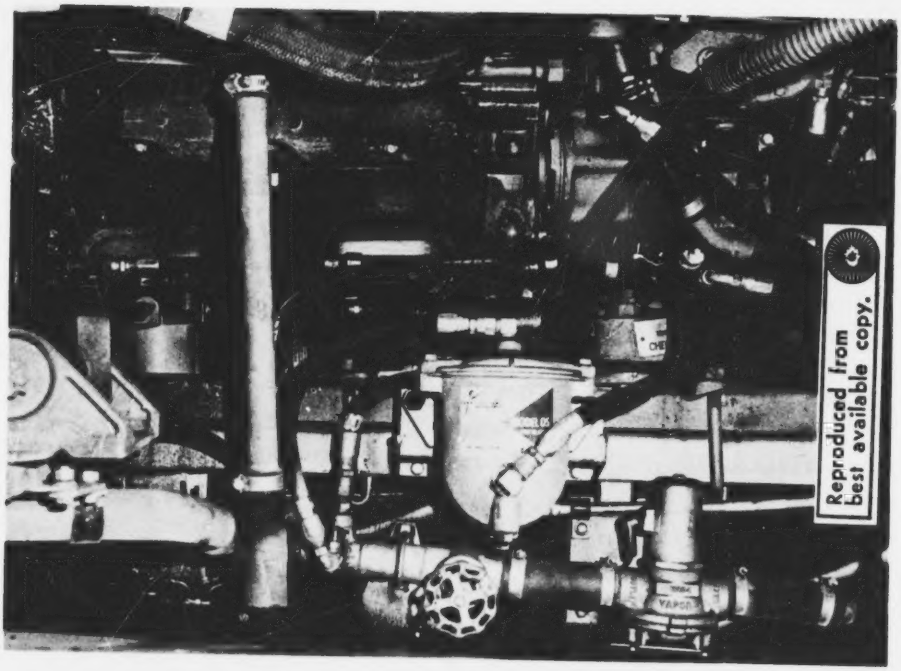


FIGURE 82. INTERCITY BUS ENGINE COMPARTMENT
Rear View



Reproduced from best available copy.

FIGURE 83. INTERCITY BUS ENGINE COMPARTMENT
Side View

TABLE 92. OVERALL SUMMARY OF ODOR EVALUATION OF INTERCITY BUSES AVERAGE ODOR PANEL RESPONSE

Operating Conditions	Bus No.	"D" Composite		"B" Burnt		"O" Oily		"A" Aromatic		"P" Pungent	
		Fuel No.									
		1*	2†	1	2	1	2	1	2	1	2
1400 rpm 60 hp (20 mph)	598	3.6	2.3	1.0	0.8	1.0	0.7	0.8	0.7	0.3	0.3
	594	2.9	2.4	1.0	0.9	0.9	0.9	0.9	0.8	0.5	0.1
	596	3.4	3.1	1.1	1.0	1.0	1.0	0.9	1.0	0.6	0.3
	Avg	3.3	2.6	1.0	0.9	1.0	0.9	0.9	0.8	0.5	0.2
1700 rpm 60 hp (25 mph)	598	3.1	2.7	1.0	0.8	1.0	0.7	0.7	0.8	0.1	0.4
	594	2.5	2.9	1.0	0.9	1.0	1.0	0.8	0.7	0.2	0.2
	596	4.3	4.1	1.1	1.2	1.1	1.1	1.1	1.1	0.8	0.5
	Avg	3.3	3.2	1.0	1.0	1.0	0.9	0.9	0.9	0.4	0.4
2000 rpm 60 hp (30 mph)	598	3.8	2.9	1.2	0.8	1.1	0.9	0.9	0.8	0.3	0.2
	594	3.6	3.3	1.1	1.0	1.0	1.0	0.9	0.8	0.4	0.4
	596	4.0	3.2	1.1	1.1	1.0	1.1	1.0	0.9	0.8	0.4
	Avg	3.8	3.1	1.1	1.0	1.0	1.0	0.9	0.8	0.5	0.3
Idle	598	3.2	4.1	0.9	1.3	1.0	1.0	0.8	1.0	0.2	0.6
	594	4.2	3.6	1.2	0.9	1.0	1.0	1.0	0.9	0.4	0.6
	596	5.1	3.7	1.6	1.2	1.1	1.1	1.2	0.9	0.9	0.4
	Avg	4.2	3.8	1.2	1.1	1.0	1.0	1.0	0.9	0.5	0.5
Idle-Acceleration	598	5.3	5.3	1.6	1.6	1.4	1.4	1.2	1.0	0.9	0.8
	594	5.3	6.0	1.7	1.7	1.4	1.6	1.1	1.2	1.0	1.1
	596	5.1	5.8	1.6	1.6	1.4	1.5	1.1	1.3	1.0	1.0
	Avg	5.2	5.7	1.6	1.6	1.4	1.5	1.1	1.2	1.0	1.0
Deceleration	598	5.4	5.2	1.8	1.8	1.5	1.4	1.2	1.3	0.8	0.7
	594	3.7	4.2	1.1	1.3	1.1	1.0	0.9	0.9	0.3	0.7
	596	4.0	3.7	1.3	1.2	1.0	1.0	1.1	0.9	0.9	0.5
	Avg	4.4	4.4	1.4	1.4	1.2	1.1	1.1	1.0	0.7	0.6

---

*Code EM-70-F.
†Code EM-90-F.

TABLE 93. OVERALL SUMMARY OF SMOKE READINGS FROM INTERCITY BUSES

Constant Speed Results
(All Open Rack, Maximum Power)

Engine Speed, rpm	Vehicle Speed, mph	Average PHS Smoke Reading, Percent Opacity					
		MCI No. 1		MCI No. 2		MCI No. 3	
		No. 1	No. 2	No. 1	No. 2	No. 1	No. 2
800	20	19.0	32.5	11.5	15.0	10.5	20.0
1000	25	8.5	15.0	5.0	7.5	5.3	9.8
1200	30	7.5	12.8	3.0	5.8	2.8	7.0
1400	35	5.8	9.0	2.5	4.5	2.3	5.0
1600	40	4.8	7.0	2.0	3.8	2.0	4.5
1800	45	3.0	5.5	1.8	3.8	2.3	4.0
2000	50	3.0	4.8	2.0	4.0	2.3	4.0
Transient Results (Max Readings) (40 hp at 30 mph Preset in Dynometer)							
First Gear		9.8	8.0	5.8	7.8	1.0	3.5
Second Gear		7.3	10.5	2.5	6.8	2.7	4.8
Third Gear		7.8	12.0	2.3	5.8	3.0	7.3
Fourth Gear		9.3	12.3	3.0	7.3	4.2	10.3

basically those used for trucks. The constant speed results, all at maximum power, covered a speed range of 800 to 2000 rpm. The acceleration through the gears was conducted with 25,000-lb inertia simulation with 40 hp preset in the dynamometer at 30 mph. Both No. 1 and No. 2 fuels were employed and the smokemeter was located so that the center line of the light beam was 5-1/2 inches from the tip of the 4-inch exhaust pipe. The operating characteristic of the two-cycle engine to produce less smoke as the engine speed was increased was demonstrated for both fuels and all units. The No. 2 fuel consistently produced about 50 percent more smoke.

Emissions other than odor and smoke were obtained under the three cruise and idle conditions The results of these measurements for the three units and both fuels are listed on Table 94. Engine speed seemed to have little effect on hydrocarbons, CO or NO. An interesting observation is that less hydrocarbons were measured when No. 2 fuel was used than No. 1 and this was consistent under all conditions and all vehicles evaluated. This may explain why slightly less odor was found by the panel when these same buses were run on No. 2 instead of No. 1 fuel. Acrolein and formaldehyde do not show this difference as clearly although total aldehydes on the average were less with the No. 2 fuel than with the No. 1 fuel. Exhaust chemistry and odor panel measurements were made simultaneously. For a complete description of procedures and detailed data on which these summaries are based, please refer to Appendix G.

TABLE 94. OVERALL SUMMARY OF EXHAUST EMISSIONS FROM INTERCITY BUSES

(As-Measured)

Operating Conditions	Bus No.	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aldehydes, ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		SO_2, ppm	
		No. 1*	No. 2†	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2
1400 rpm 60 hp (20 mph)	598	152	116	3.9	3.7	600	437	3	3	22	13	5	4	756	846	707	727	0	0.4
	594	180	150	3.9	4.1	443	222	4	4	24	16	3	3	913	779	771	670	1.0	0.5
	596	156	164	3.9	4.3	675	371	4	3	12	15	6	10	930	941	800	751	1.4	3.6
	Avg	163	143	3.9	4.0	573	343	4	3	19	15	5	6	866	855	759	716	0.8	1.5
1700 rpm 60 hp (25 mph)	598	166	115	3.9	3.9	545	437	4	3	21	13	5	3	661	771	620	710	0.1	0.5
	594	185	153	3.9	4.2	317	246	4	4	26	14	4	4	705	771	700	632	1.1	0.7
	596	160	176	4.1	4.3	714	494	4	3	12	15	6	14	907	855	764	670	1.4	3.3
	Avg	170	148	4.0	4.1	525	392	4	3	20	14	5	7	758	799	695	671	0.9	1.5
2000 rpm 60 hp (30 mph)	598	167	122	3.9	3.9	623	437	3	3	18	13	6	4	664	736	572	632	0	0.7
	594	195	161	4.0	4.1	248	235	4	4	26	16	4	4	716	690	605	630	1.3	0.7
	596	172	164	4.3	4.3	673	391	4	4	11	14	6	12	716	791	725	650	1.3	3.0
	Avg	178	149	4.1	4.1	515	354	4	4	18	14	5	7	699	739	634	637	0.9	1.5
Idle	598	190	140	1.0	1.0	555	504	4	3	23	16	9	6	207	251	237	255	0	0.1
	594	230	176	0.9	1.2	374	323	5	4	27	18	5	5	234	234	209	235	0.5	0.3
	596	197	197	1.0	1.1	498	415	4	4	28	16	9	11	254	271	240	230	0.4	1.1
	Avg	206	171	1.0	1.1	476	414	4	4	26	17	8	7	232	252	229	240	0.3	0.5

---

*Code EM-70-F.

†Code EM-90-F.

X. SUMMARY

The basic theme of Part III was to determine effectiveness of control methods and investigate an instrumental method for odor measurement relatable to the human panel. The former included many separate phases, each a small project of itself, while the latter was a continuing study. A brief review of the highlights and key points of this 16-month effort are listed below:

1. The six-month fleet test of the commercially available diesel fuel odor additive in three two-cycle Detroit Diesel 6V-71 E powered municipal buses showed the overall lack of effect this material had on perceived odor. Though the additive used was the best of several available and subjected to screening tests prior to the fleet test, it seems that the additive, according to the ten-person trained panel operating under laboratory controlled conditions, resulted in essentially the same D, B, O, A, and P ratings. The additive also had no effect on smoke or the chemical emissions of HC, CO, CO_2, acrolein, NO, NO_2, NO_x, formaldehyde, and total aldehydes.

2. The six-month fleet test of a catalytic muffler device in three two-cycle Detroit Diesel 6V-71 E powered municipal coaches resulted in inconsistent reductions in odor though certain of the chemical emissions such as HC and CO were generally always reduced. Performance of the unit was found best when it was new and generally regeneration of the catalyst was helpful in regaining the device's performance. No effect on visible smoke was found. Selection of the device for fleet test was as a result of screening test of a number of candidate mufflers. The unit selected, though commercially used on stationary and construction equipment, had to be adapted for street test and every advantage of size and placement was given the device. The device, operating with the exhaust from the rear bank of the engine, sometimes reduced the perceived odor, sometimes had no statistical effect, and occasionally resulted in a more pronounced odor. When the overall intensity, "D," and burnt quality "B," were reduced, the pungent quality sometimes became more noticeable. Hydrocarbon content in the exhaust was generally less when the odor ratings were reduced relative to the standard muffler.

3. Odor and smoke from a group of ten similar municipal buses powered by Detroit Diesel 6V-71 N type engines were measured under conditions similar to those used with the E type engines during Part I. Both odor and smoke were proven to be less from the N type engine than the older E engine in this application. Odor was 1 to 2 "D" numbers less under most conditions and smoke was less than half of that with the E engine. The differences were both statistically and substantially significant with odor reduction greatest during the deceleration conditions.

4. The odor, smoke, and exhaust emissions measurement procedures developed for the municipal bus and intercity truck were successfully modified to permit operation of diesel-powered vehicles heretofore not studied. Adjustments in dynamometer operation were mainly to use 25,000-lb inertia for single-drive axle tractors and to change gear shift points and vehicle load to stay within the general guidelines established during Part I. Limited odor, smoke, and other emissions were obtained from six vehicles composed of four four-cycle powered tractors (1 turbocharged) and two two-cycle powered tractors. The data are presented to permit comparisons and further analysis. Complete emissions maps of all loads and speeds were not obtained.

5. A number of catalytic devices employing both transition metal and precious metal catalyst coatings were given a screening test after 1 month of street operation on a bus. Most devices did not show the sufficient or consistent reductions in emissions to justify an extended fleet test. One device failed structurally during the street operation. The city bus exhaust represents one of the most difficult to treat by catalysis due to the low exhaust temperature and unsteady flow conditions with extended engine idle. The precious metal (platinum) catalysts have been more effective than the transition metal materials tested to date.

6. A series of experiments were made with the Bureau of Mines and SwRI trained odor panels at SwRI's Vehicle Emissions Research Laboratory. Excellent agreement was found in the ratings of the two panels for the "D" diesel composite, the most important indicator of diesel odor. Good agreement was also found for most of the qualities of "B" and "O" with

differences in the "A" and "P" quality ratings. The experiments included both two-cycle and four-cycle engine operation.

A retest of an electrostatic precipitator for removal of exhaust smoke was conducted. The unit was completely unsuccessful in reducing the visible smoke via the PHS smokemeter. As soon as carbon covered the ionizer section, the electrostatic potential dissipated.

7. Three Motor Coach Industries intercity type buses powered by Detroit Diesel 8V-71 N engines were operated on both a No. 1 and a No. 2 fuel to determine their odor, smoke, and other emissions under road-like conditions. Dynamometer procedures were modified to acquire limited baseline data with these "Greyhound type" buses. Contrary to previous experience with city buses, fuel seemed to have little or no effect on perceived odor. Otherwise, emissions were similar to other N type two-cycle engines.

8. Tests were made to establish the performance of an improved needle type or "N" injector. In conducting these tests with a set of used crown type "S" injectors as base, it was found that the modified "N" injectors were only slightly better than the "N" injector. The "N" injector, however, resulted in substantially lower smoke, odor, and other pertinent emissions like HC, CO, acrolein, etc., under all conditions investigated. These tests were conducted in two city buses powered by the two-cycle 6V-71 E engine. The "N" injectors in the E engine had the effect of reducing emissions to that common from the 6V-71 N engine. These tests were some of the most significant and promising of those made of potential control methods during the Long Range Investigation. Reductions of "D" ratings on the order of two numbers, smoke to 1/3 and hydrocarbons to 1/4 of that from the E engine make the use of N or modified N injectors an attractive control approach for the vehicle equipped with "S" type injectors.

9. Odor, chemistry, and correlation studies were conducted throughout the 16-month project. The intent of these studies, to develop an instrumental method for odor measurement, was termed a success even though the correlation experiments did not show the GLC analyses of the polar compounds in the exhaust condensate to be the best for odor prediction. Rather, total unburned hydrocarbons, as measured by the SwRI system, was found to be the single best indicator of diesel odor of all parameters investigated. The final correlation experiments involved eleven vehicles (eight two-cycle buses and trucks and three four-cycle trucks). Equations relating "D," "B," "O," "A," and "P" odor panel ratings to the various exhaust parameters routinely measured and the special bag samples of exhaust trapped, condensed, and analyzed by GLC were determined as a result of a multiple linear regression analysis. In addition to hydrocarbons, the other parameters such as NO_x, acrolein, and occasionally total aldehydes are identified as are some of the 12 GLC peaks also included in the computer analysis. The only restriction made was to present the odor panel exhaust diluted 100:1 regardless of whether it was a truck or bus, as dilution level is a function of vehicle design and not necessarily the engine type.

In conclusion of this summary, a great deal more has been learned regarding the production and control of odor and smoke from diesel-powered vehicles. Just as smoke can be limited initially by engine design, so does engine design have a real effect on odor as illustrated, for example, by the N engine or the "N" injector equipped two-cycle engine in municipal bus service. Generally speaking, add-on devices or other methods tested to date have lacked the overall consistent improvement deemed necessary for widespread usage.

XI. RECOMMENDATIONS

Based on the specific items of work accomplished during Part III and the experience gained during Parts I and II, the following recommendations are offered for consideration.

1. Catalytic mufflers and additives for reduction of odor, smoke, and other additives should continue to be considered by means of screening test after an initial period of field operation where possible. Expensive fleet evaluation should, however, be made of only items which show statistically valid results during the screening test and are currently or in the near future commercially available.

2. Comparisons of odor and smoke from two groups of ten buses powered by 6V-71 E and N engines show conclusively the advantages of the "N" engine for less odor and smoke. Although the N engine features both a higher compression ratio and the needle or "N" type injectors, it seems that the use of "N" injectors in place of the crown or "S" injectors in the E type engine will have the same effect on odor, smoke, and other emissions as the N engine.

3. Though the "N" injector is a proven item of hardware, a 6- to 9-month fleet test of the improved "N" injector to establish its odor, smoke, and exhaust emissions performance with time relative to the "S" injector equipped 6V-71 E two-cycle engine may be justified. The fleet test of this, or a similar smoke and/or odor control method should follow the same procedure of back-to-back type tests used in Part III.

4. The operation of various types of vehicles heretofore not studied and acquisition of limited baseline odor, smoke, and emissions data strengthened the basic knowledge of diesel emissions. Additional vehicle studies are recommended with emphasis on turbocharged four-cycle tractors and medium duty city delivery type vehicles.

5. The availability of a fast response continuous hydrocarbon analyzer along with the NO and CO NDIR equipment makes possible continuous recording of pertinent exhaust parameters during cyclic vehicle operation. Though the CO from diesels is very low and the HC is generally lower than controlled automobiles, a limited look at dynamometer methods and cyclic procedures is justified.

6. Studies of the effects of inlet air humidity and injection timing appear to be important in developing future test procedures and determining what possible deleterious effects advancing injection has on emissions other than smoke. Inlet air humidity has been shown to affect gasoline engine NO emissions and could also have a similar effect on the diesel. Limited studies of both areas are recommended.

7. The success to date in relating perceived odor via the human panel to exhaust parameters measured by instruments suggests further efforts. The less than optimum correlation of the GLC analyses of polar compounds in the exhaust condensate will mean shifting more emphasis to the measurement by general classes of compounds represented by the total hydrocarbons. This is prompted by the generally good correlation of odor and total hydrocarbons. It is likely that subtractive columns in conjunction with the total analysis and possibly evaluation of the role of the light hydrocarbons by GLC and their potential correlation should be included in future efforts. This area of research is probably the most difficult yet important of the efforts underway and its continuation is recommended.

8. Development of a quick screening test procedure to determine the acute toxicity of diesel fuel additives as well as ensure the additive has no gross deleterious effect in other emissions from the diesel engine is suggested. Acute toxicity determinations using white mice exposed to known death rate concentrations of exhaust before and after the additive is used may prove to be a reliable early indicator of possible toxicity effects.

9. Development of a suitable mass type smokemeter may be a long range need in order to express smoke emissions on a grams per unit of volume of exhaust basis. Such a sampling method would need to filter the smoke particulate onto a preweighed filter paper under constant speed as well as the transient acceleration modes of the current Federal smoke cycle.

Other applications of a null balance type isokinetic sampler would be to acquire a true proportional sample of exhaust (diesel and/or gasoline vehicle) for analysis of HC, CO, NO_x and other emissions as well as detailed analysis of solid particles of combustion of metallic and organic type fuel additives.

10. In addition to emissions from vehicles which operate on streets and highways, diesels are widely used in construction, farm equipment, and off-highway applications and are almost exclusively used to power railroad locomotives and most ships. An increasing number are used in stationary applications for electric power generation, irrigation pumps, total energy complexes, etc. Though these areas may not currently be of significance, it is possible that they will be considered in the future. Most of the current measurement technology can be extended and applied in these areas with only a minimal amount of modification.

11. Practically all diesel engines emit crankcase or blowby gases to the atmosphere. Though piston blowby is mostly air, this blowby may mix with hot oil vapors and result in hydrocarbon emission of unknown amount or type. Though there is relatively little fuel evaporative emissions from diesel fuel due to its higher boiling range versus gasoline, noticeable fuel vapors may be released to the atmosphere from diesel-powered vehicle fuel tanks. Most fuel injectors and some types of injection pumps depend on the fuel as a heat transfer media to keep working parts cool. Thus, many engines have a hot fuel return to the tank, hot enough to produce noticeable amounts of fuel vapor to be discharged. The crankcase and fuel tank hydrocarbon emissions should be ascertained with several types of road vehicles and, if possible, HC component analysis by GLC be obtained.

12. Diesel engines used in motor vehicles starting January 1, 1970, will have to meet the Federal limits of 20 percent (lug down) and 40 percent (acceleration) opacity. A 1000-hour durability test is conducted to assure smoke control effectiveness. In the case with the gasoline powered auto, surveillance studies have been conducted to provide the needed feedback on how well the control method is functioning in the hands of the operator. Similar information on smoke production from controlled engines with time would provide information which could be helpful in planning future control efforts and the rate of deterioration. Such a surveillance test could be moderate in scope but an equivalent chassis dynamometer procedure to the current stationary method would be needed.

LIST OF REFERENCES

1. Springer, Karl J., "An Investigation of Diesel Powered Vehicle Odor and Smoke - Part I," Final Report to the U.S. Public Health Service, Contract PH 86-66-93, March 1967.

2. Springer, Karl J., and Stahman, Ralph C., "An Investigation of Diesel Powered Vehicle Odor and Smoke," National Petroleum Refiners Association Paper No. FL 66 46, September 15-16, 1966.

3. Springer, Karl J., "An Investigation of Diesel Powered Vehicle Odor and Smoke - Part II," Final Report to the U.S. Public Health Service, Contract PH 86-67-72, February 1968.

4. Stahman, Ralph C., Kittredge, George D., and Springer, Karl J., "Smoke and Odor Control for Diesel-Powered Trucks and Buses," Society of Automotive Engineers Paper No. 680443, May 1968.

5. Springer, Karl J. and Hare, Charles T., "Four Years of Diesel Odor and Smoke Control Technology Evaluations - A Summary," American Society of Mechanical Engineers Paper No. 69-WA/APC-3, presented at Winter Annual Meeting, Los Angeles, November 17, 1969.

6. Springer, Karl J. and Dietzmann, Harry E., "Diesel Exhaust Hydrocarbon Measurement - A Flame Ionization Method," Society of Automotive Engineers, presented at the Annual Meeting, Detroit, Michigan, January 15, 1970.

7. Turk, Amos, "The Selection and Training of Judges for the Sensory Evaluation of Odor Intensity and Character of Diesel Exhaust," PHS Publication No. 999-AP-32, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

8. Letter from National Air Pollution Control Administration entitled "PHS Smokemeter Modifications," March 4, 1969.

9. "Revised Preliminary Operating Instructions for Use of the U.S. Public Health Service Full-Flow, Light-Extinction Smokemeter," April 1969.

10. Forester, D. D. and Hubbard, J. E., Presentation at the Mechanical Division Session of the American Transit Association, May 7, 1968.

11. "New 'N' Injector Spray Tip Assemblies," Detroit Diesel Service Information Bulletin, M. M. Ref. 2.1.1, No. 69-I-12 Revised, Series 53 and 71, June 27, 1969.

12. Bi-Monthly Progress Report No. 3 under Contract PH 22-68-23, November 1968.

APPENDIXES

A. Results of Initial Screening Tests and Fleet Test of a Diesel Fuel Odor Additive
B. Results of Screening and Fleet Test of a Diesel Exhaust Catalytic Muffler
C. Municipal Bus Variability Results
D. Baseline Emissions from a Variety of Diesel-Powered Trucks
E. Effect of Injectors on Emissions
F. (Instrument--Odor Panel Correlation) Odor, Smoke, and Chemistry Results from Vehicles and Engines
G. Odor, Smoke and Other Emissions from an Intercity Coach

APPENDIX A

RESULTS OF INITIAL SCREENING TESTS AND FLEET TEST OF A DIESEL FUEL ODOR ADDITIVE

TABLE 1. ODOR EVALUATION CONDITIONS EMPLOYED DURING INVESTIGATION OF THE EFFECT OF THE JACOBS ENGINE BRAKE

Vehicle Data:	GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E Series, two-valve engine. Muffler under coach. Type 60S fuel injectors.
Sampling Data:	Constant sample flow at 100:1 dilution level.
Inertia:	Full inertia simulation via SwRI system.

OPERATING CONDITIONS

Type Operation	Vehicle Speed, mph	Vehicle Load, hp	For Details, Refer to:
I. Constant Speed	20	40	Table 2
II. Constant Speed	40	40	Table 2
III. Constant Speed-Idle	--	--	Table 3
IV. Idle-Acceleration	0-20	0	Table 4
V. Constant Speed-Deceleration	40-0	40 hp at 40 mph	Table 5

TABLE 2. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature. Air conditioning "off."

Inertia: Full inertia simulation via SwRI system.

Vehicle Speeds and Loads: The following are to be run with the transmission in the drive range:

Vehicle Speed, mph	Engine Speed, rpm	Vehicle Load, hp	Power Level, approx
20	890	40	Near max
40	1590	40	2/3 rack

Procedure:

(1) Operate at given stable speed and load for 15 sec.

(2) Turn "on" 45-sec panel warning light, turn dilution system to "auto" control, and continue stable operation.

(3) Ring bell for panel to begin odor evaluation and maintain stable operation.

(4) Panel turns "off" light when evaluation is complete. The evaluation requires 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(5) When light goes "off," turn dilution system to "man" control, and decelerate to idle. Permit rear tires to rotate and cool.

(6) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts when light goes "out.")

Run Time: Approximately 3 min., with 5-min rest - 8 min.

TABLE 3. ENGINE IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.
Sample Method:	Constant flow at 100:1 dilution level.
Warm-up:	A minimum of three complete runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature. Air conditioning "off."
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speed and Load:	Operate at 30 mph and 40 hp for 1 min, followed by closed-rack deceleration to downshift (17 mph), and allow engine to idle.
Procedure:	(1) Operate at 30 mph and 40 hp, stable. (2) Turn "on" panel warning light and maintain stable operation. (3) After 1 min of stable sustained operation, closed-rack decelerate to downshift and allow engine to idle. (4) Turn dilution system to "auto" 2 sec after downshift. (5) Ring bell to begin panel exposure 15 sec after downshift. (6) Panel turns "off" light when evaluation is complete. The evaluation requires 50 to 70 sec to complete. Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period. (7) When light is "off," turn dilution system to "man" control and permit rear tires to rotate and cool. (8) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts when light goes "out.")
Run Time:	Approximately 3 min, with 5-min rest - 8 min.

TABLE 4. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature. Air conditioning "off."

Inertia: Full inertia simulation via SwRI system.

Vehicle Speed and Load: Idle for 1 min followed by full-rack acceleration to 20 mph with inertia only.

Procedure:

(1) Turn "on" 60-sec panel warning light, turn dilution system to "auto" and idle for 1 min, rear wheels stationary.

(2) Accelerate full-rack to 20 mph under full inertia simulation.

(3) Ring bell for panel exposure 3 sec after start of acceleration.

(4) Hold 20 mph for 15 sec, turn off engine and turn dilution system to "man."

(5) Two minutes after turning "off" engine, start engine and allow to idle. Turn on 60-sec panel warning light and turn dilution system to "auto." Allow to idle for 1 min, rear wheels stationary.

(6) Repeat items (2) through (5) above. The original and repeat idle-acceleration constitute one run.

(7) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts when engine is turned "off.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite, and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6.5 min, with 5-min rest - 11.5 min.

TABLE 5. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator removed.

Inertia: Full inertia simulation via SwRI system.

Vehicle Speed and Load: Operate at stable 40 mph and 40 hp for 1 min, followed by closed-rack deceleration.

Procedure:

(1) Operate at 40 mph and 40 hp, stable.

(2) Turn "on" 60-sec panel warning light, turn dilution system to "auto," and maintain stable operation.

(3) After 1 min of stable sustained operation, closed-rack decelerate to downshift.

(4) Ring bell for panel exposure at 23 mph.

(5) On reaching downshift (17 mph), permit engine to idle and cool tires. Turn "off" light and turn dilution system to "man."

(6) Two minutes after downshift, return to 40-mph and 40-hp condition.

(7) Repeat items (2) through (5) above. The original and repeat constant speed-deceleration constitute one run.

(8) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts on engine downshift.)

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities, with only an original and a repeat exposure (sniff).

Run Time: Approximately 7 min, with 5-min rest - 12 min.

TABLE 6. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 9, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run		Average Panel Responses				
		"D"	"B"	"O"	"A"	"P"
No.*	Operating Condition	Composite	Burnt	Oily	Aromatic	Pungent
1	I. Constant Speed	5.6	1.7	1.4	1.2	0.2
3	" "	5.4	1.3	1.2	1.2	0.3
11	" "	4.8	1.2	1.1	1.1	0.4
24	" "	5.8	1.8	1.3	1.6	0.4
		5.4	1.5	1.2	1.3	0.3
5	II. Constant Speed	5.3	1.4	1.2	1.1	0.6
9	" "	5.6	1.3	1.3	1.1	0.6
16	" "	5.6	1.6	1.2	1.1	0.6
21	" "	5.7	1.8	1.4	1.3	0.4
		5.6	1.5	1.3	1.2	0.6
6	III. Idle	7.0	2.1	1.8	1.7	1.0
10	"	6.7	2.0	1.6	1.8	1.0
17	"	6.8	2.0	1.8	1.2	1.1
22	"	6.7	2.0	1.7	1.7	0.7
		6.8	2.0	1.7	1.6	1.0
13	IV. Idle-Acceleration	8.0	2.2	1.9	1.2	1.3
15	" "	7.6	2.6	2.1	1.3	1.3
18	" "	6.7	2.2	1.8	1.3	1.0
20	" "	7.1	2.3	2.1	1.4	1.1
		7.8	2.3	2.0	1.3	1.2
2	V. Deceleration	7.7	2.0	1.3	1.4	0.8
7	"	6.8	2.0	1.3	1.6	1.0
14	"	7.6	2.4	1.9	1.7	1.3
23	"	7.0	2.3	1.6	1.4	1.1
		7.3	2.2	1.5	1.5	1.1

---

*Runs 4, 8, 12 and 19 were conducted without exhaust sample.

TABLE 6A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676	Operating Conditions: See Table 1
Date: May 9, 1968	Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses							
		0	4	5	6	7	8	9	Average
1	Constant Speed		1	2	6				5.6
2	Deceleration				4	5			7.7
3	Constant Speed			5	4				5.4
4	Blank	9							0
5	Constant Speed			6	3				5.3
6	Idle					9			7.0
7	Deceleration				1	8			6.8
8	Blank	9							0
9	Constant Speed			6	1	2			5.6
10	Idle				4	4	1		6.7
11	Constant Speed		5	2	1	1			4.8
12	Blank	9							0
13	Idle-Acceleration					6	3		8.0
14	Deceleration				1	2	6		7.6
15	Idle-Acceleration					5	2	2	7.6
16	Constant Speed			4	4	1			5.6
17	Idle				2	7			6.8
18	Idle-Acceleration				6	1	1	1	6.7
19	Blank	9							0
20	Idle-Acceleration				2	4	3		7.1
21	Constant Speed			2	7				5.7
22	Idle				2	6	1		6.7
23	Deceleration				3	3	3		7.0
24	Constant Speed			1	8				5.8

TABLE 6B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 9, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Average
1	Constant Speed		3	6		1.7
2	Deceleration			9		2.0
3	Constant Speed		6	3		1.3
4	Blank	9				0
5	Constant Speed		5	4		1.4
6	Idle			8	1	2.1
7	Deceleration			9		2.0
8	Blank	9				0
9	Constant Speed		6	3		1.3
10	Idle			9		2.0
11	Constant Speed		7	2		1.2
12	Blank	9				0
13	Idle-Acceleration			7	2	2.2
14	Deceleration			5	4	2.4
15	Idle-Acceleration			4	5	2.6
16	Constant Speed		4	5		1.6
17	Idle			9		2.0
18	Idle-Acceleration			7	2	2.2
19	Blank	9				0
20	Idle-Acceleration			6	3	2.3
21	Constant Speed		2	7		1.8
22	Idle		1	7	1	2.0
23	Deceleration			6	3	2.3
24	Constant Speed		2	7		1.8

TABLE 6C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 9, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses				
		0	1	2	3	Average
1	Constant Speed		5	4		1.4
2	Deceleration		6	3		1.3
3	Constant Speed		7	2		1.2
4	Blank	9				0
5	Constant Speed		7	2		1.2
6	Idle		2	7		1.8
7	Deceleration		6	3		1.3
8	Blank	9				0
9	Constant Speed		6	3		1.3
10	Idle		4	5		1.6
11	Constant Speed		8	1		1.1
12	Blank	9				0
13	Idle-Acceleration		1	8		1.9
14	Deceleration		2	6	1	1.9
15	Idle-Acceleration			8	1	2.1
16	Constant Speed	1	5	3		1.2
17	Idle		2	7		1.8
18	Idle-Acceleration		2	7		1.8
19	Blank	9				0
20	Idle-Acceleration			8	1	2.1
21	Constant Speed		5	4		1.4
22	Idle		3	6		1.7
23	Deceleration		4	5		1.6
24	Constant Speed		6	3		1.3

TABLE 6D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 9, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	3	Average
1	Constant Speed		7	2		1.2
2	Deceleration		5	4		1.4
3	Constant Speed		7	2		1.2
4	Blank	9				0
5	Constant Speed	1	6	2		1.1
6	Idle		4	4	1	1.7
7	Deceleration		4	5		1.6
8	Blank	9				0
9	Constant Speed	1	6	2		1.1
10	Idle		2	7		1.8
11	Constant Speed		8	1		1.1
12	Blank	9				0
13	Idle-Acceleration	2	3	4		1.2
14	Deceleration		3	6		1.7
15	Idle-Acceleration		6	3		1.3
16	Constant Speed		8	1		1.1
17	Idle		7	2		1.2
18	Idle-Acceleration		6	3		1.3
19	Blank	9				0
20	Idle-Acceleration	1	3	5		1.4
21	Constant Speed		6	3		1.3
22	Idle		3	6		1.7
23	Deceleration		5	4		1.4
24	Constant Speed		4	5		1.6

TABLE 6E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676
Date: May 9, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	7	2		0.2
2	Deceleration	2	7		0.8
3	Constant Speed	6	3		0.3
4	Blank	9			0
5	Constant Speed	4	5		0.6
6	Idle	1	7	1	1.0
7	Deceleration		9		1.0
8	Blank	9			0
9	Constant Speed	4	5		0.6
10	Idle		9		1.0
11	Constant Speed	5	4		0.4
12	Blank	9			0
13	Idle-Acceleration		6	3	1.3
14	Deceleration		6	3	1.3
15	Idle-Acceleration		6	3	1.3
16	Constant Speed	4	5		0.6
17	Idle	1	6	2	1.1
18	Idle-Acceleration	1	7	1	1.0
19	Blank	9			0
20	Idle-Acceleration		8	1	1.1
21	Constant Speed	5	4		0.4
22	Idle	2	6	1	0.7
23	Deceleration	1	6	2	1.1
24	Constant Speed	5	4		0.4

TABLE 6B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 9, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		3	6		1.7
2	Deceleration			9		2.0
3	Constant Speed		6	3		1.3
4	Blank	9				0
5	Constant Speed		5	4		1.4
6	Idle			8	1	2.1
7	Deceleration			9		2.0
8	Blank	9				0
9	Constant Speed		6	3		1.3
10	Idle			9		2.0
11	Constant Speed		7	2		1.2
12	Blank	9				0
13	Idle-Acceleration			7	2	2.2
14	Deceleration			5	4	2.4
15	Idle-Acceleration			4	5	2.6
16	Constant Speed		4	5		1.6
17	Idle			9		2.0
18	Idle-Acceleration			7	2	2.2
19	Blank	9				0
20	Idle-Acceleration			6	3	2.3
21	Constant Speed		2	7		1.8
22	Idle		1	7	1	2.0
23	Deceleration			6	3	2.3
24	Constant Speed		2	7		1.8

TABLE 7. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 10, 1968

Operating Conditions: See Table 1
Fuel: EM-64-F (Additive A)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
5	I. Constant Speed	5.1	1.2	1.0	0.9	0.7
8	" "	5.0	1.1	1.0	1.0	0.6
18	" "	4.4	1.2	1.1	0.9	0.4
20	" "	4.4	1.1	1.1	0.8	0.3
		4.7	1.2	1.1	0.9	0.5
1	II. Constant Speed	5.0	1.0	1.0	1.0	0.8
3	" "	4.7	1.0	1.0	0.9	0.3
10	" "	4.4	1.1	1.1	0.9	0.1
23	" "	5.2	1.1	1.1	1.1	0.1
		4.8	1.1	1.1	1.0	0.3
2	III. Idle	6.3	2.0	1.4	1.3	1.0
11	"	6.7	1.9	1.6	1.4	1.0
17	"	6.4	1.8	1.6	1.3	1.0
24	"	6.0	1.9	1.4	1.1	1.1
		6.4	1.9	1.5	1.3	1.0
6	IV. Idle-Acceleration	6.8	2.0	1.7	1.2	1.1
14	" "	7.3	2.2	2.0	1.6	1.1
16	" "	7.4	2.2	2.0	1.2	1.7
22	" "	7.8	2.3	2.0	1.6	1.7
		7.3	2.2	1.9	1.4	1.4
7	V. Deceleration	6.7	2.0	1.7	1.4	0.9
13	"	6.9	2.0	1.8	1.3	1.1
15	"	7.1	2.0	1.9	1.3	1.6
21	"	6.5	2.0	1.8	1.6	1.0
		6.9	2.0	1.8	1.4	1.2

---

*Runs 4, 9, 12 and 19 were conducted without exhaust sample.

TABLE 7A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: May 10, 1968

Operating Conditions: See Table 1
Fuel: EM-64-F (Additive A)

Run	Operating	"D" Diesel Composite Responses						
No.	Condition	0	4	5	6	7	8	Average
1	Constant Speed			9				5.0
2	Idle				6	3		6.3
3	Constant Speed		3	6				4.7
4	Blank	9						0
5	Constant Speed		1	6	2			5.1
6	Idle-Acceleration				3	5	1	6.8
7	Deceleration				3	6		6.7
8	Constant Speed		1	7	1			5.0
9	Blank	9						0
10	Constant Speed		5	4				4.4
11	Idle				4	4	1	6.7
12	Blank	9						0
13	Deceleration				1	8		6.9
14	Idle-Acceleration					6	3	7.3
15	Deceleration					8	1	7.1
16	Idle-Acceleration					5	4	7.4
17	Idle				6	2	1	6.4
18	Constant Speed		5	4				4.4
19	Blank	9						0
20	Constant Speed		5	4				4.4
21	Deceleration				1	8		6.9
22	Idle-Acceleration					2	7	7.8
23	Constant Speed			8		1		5.2
24	Idle				9			6.0

TABLE 7B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 10, 1968

Operating Conditions: See Table 1
Fuel: EM-64-F (Additive A)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		9			1.0
2	Idle			9		2.0
3	Constant Speed		9			1.0
4	Blank	9				0
5	Constant Speed		7	2		1.2
6	Idle-Acceleration			9		2.0
7	Deceleration			9		2.0
8	Constant Speed		8	1		1.1
9	Blank	9				0
10	Constant Speed		8	1		1.1
11	Idle		1	8		1.9
12	Blank	9				0
13	Deceleration			9		2.0
14	Idle-Acceleration			7	2	2.2
15	Deceleration			9		2.0
16	Idle-Acceleration			9	2	2.2
17	Idle		2	7		1.8
18	Constant Speed		7	2		1.2
19	Blank	9				0
20	Constant Speed		8	1		1.1
21	Deceleration			9		2.0
22	Idle-Acceleration			6	3	2.3
23	Constant Speed		8	1		1.1
24	Idle		1	8		1.9

TABLE 7C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 10, 1968

Operating Conditions: See Table 1
Fuel: EM-64-F (Additive A)

Run	Operating	"O" Oily Responses			
No.	Condition	0	1	2	Average
1	Constant Speed		9		1.0
2	Idle		5	4	1.4
3	Constant Speed		9		1.0
4	Blank	9			0
5	Constant Speed		9		1.0
6	Idle-Acceleration		3	6	1.7
7	Deceleration		3	6	1.7
8	Constant Speed		9		1.0
9	Blank	9			0
10	Constant Speed		8	1	1.1
11	Idle		4	5	1.6
12	Blank	9			0
13	Deceleration		2	7	1.8
14	Idle-Acceleration			9	2.0
15	Deceleration		1	8	1.9
16	Idle-Acceleration			9	2.0
17	Idle		4	5	1.6
18	Constant Speed		8	1	1.1
19	Blank	9			0
20	Constant Speed		8	1	1.1
21	Deceleration		2	7	1.8
22	Idle-Acceleration		9		2.0
23	Constant Speed		8	1	1.1
24	Idle		5	4	1.4

TABLE 7D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 10, 1968

Operating Conditions: See Table 1
Fuel: EM-64-F (Additive A)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	3	Average
1	Constant Speed		9			1.0
2	Idle		6	3		1.3
3	Constant Speed	1	8			0.9
4	Blank	9				0
5	Constant Speed	1	8			0.9
6	Idle-Acceleration		7	2		1.2
7	Deceleration		5	4		1.4
8	Constant Speed		9			1.0
9	Blank	9				0
10	Constant Speed	1	8			0.9
11	Idle		5	4		1.4
12	Blank	9				0
13	Deceleration	1	4	4		1.3
14	Idle-Acceleration		4	5		1.6
15	Deceleration	1	5	2	1	1.3
16	Idle-Acceleration		7	2		1.2
17	Idle		6	3		1.3
18	Constant Speed	2	6	1		0.9
19	Blank	9				0
20	Constant Speed	2	7			0.8
21	Deceleration		4	5		1.6
22	Idle-Acceleration		4	5		1.6
23	Constant Speed		8	1		1.1
24	Idle		8	1		1.1

TABLE 7E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676
Date: May 10, 1968

Operating Conditions: See Table 1
Fuel: EM-64-F (Additive A)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	2	7		0.8
2	Idle		9		1.0
3	Constant Speed	6	3		0.3
4	Blank	9			0
5	Constant Speed	3	6		0.7
6	Idle-Acceleration		7	2	1.1
7	Deceleration	2	6	1	0.9
8	Constant Speed	4	5		0.6
9	Blank	9			0
10	Constant Speed	8	1		0.1
11	Idle	1	7	1	1.0
12	Blank	9			0
13	Deceleration	2	4	3	1.1
14	Idle-Acceleration	2	4	3	1.1
15	Deceleration		4	5	1.6
16	Idle-Acceleration		3	6	1.7
17	Idle	1	7	1	1.0
18	Constant Speed	5	4		0.4
19	Blank	9			0
20	Constant Speed	6	3		0.3
21	Deceleration	1	7	1	1.0
22	Idle-Acceleration		3	6	1.7
23	Constant Speed	8	1		0.1
24	Idle		7	2	1.1

TABLE 8. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 13, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
6	I. Constant Speed	4.3	1.1	1.1	1.0	0.3
8	" "	4.9	1.4	0.9	1.1	0.5
12	" "	5.9	1.9	1.7	1.1	0.7
20	" "	4.3	1.3	1.0	0.8	0.2
		4.9	1.4	1.2	1.0	0.4
2	II. Constant Speed	4.7	1.3	1.2	1.0	0.1
17	" "	5.6	1.8	1.6	1.0	0.6
19	" "	6.0	1.8	1.6	1.1	0.7
23	" "	6.1	1.9	1.6	1.2	0.8
		5.6	1.7	1.5	1.1	0.6
5	III. Idle	6.8	2.1	1.8	1.4	1.3
13	"	6.8	2.3	1.9	1.1	1.4
18	"	6.9	1.9	2.0	1.5	0.9
22	"	6.1	2.0	1.9	0.8	0.9
		6.7	2.1	1.9	1.2	1.1
4	IV. Idle-Acceleration	6.8	2.1	2.0	1.1	1.3
10	" "	7.3	2.2	2.0	1.7	1.5
15	" "	6.4	2.1	1.9	1.2	1.0
24	" "	7.8	2.3	2.2	1.6	1.3
		7.1	2.2	2.0	1.4	1.3
1	V. Deceleration	6.9	2.2	1.2	1.2	1.1
9	"	6.8	2.2	1.2	1.2	1.3
16	"	7.0	2.1	1.5	1.5	0.8
21	"	7.5	2.3	1.3	1.3	1.2
		7.1	2.2	1.3	1.3	1.1

---

*Runs 3, 7, 11 and 14 were conducted without exhaust sample.

TABLE 8A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: May 13, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses 0	4	5	6	7	8	Average
1	Deceleration				4	3	3	6.9
2	Constant Speed		5	3	2			4.7
3	Blank	10						0
4	Idle-Acceleration				2	8		6.8
5	Idle				5	2	3	6.8
6	Constant Speed		7	3				4.3
7	Blank	10						0
8	Constant Speed		1	9				4.9
9	Deceleration				4	4	2	6.8
10	Idle-Acceleration				1	5	4	7.3
11	Blank	10						0
12	Constant Speed			1	9			5.9
13	Idle				2	8		6.8
14	Blank	10						0
15	Idle-Acceleration				6	4		6.4
16	Deceleration			1	1	5	3	7.0
17	Constant Speed			6	2	2		5.6
18	Idle				3	5	2	6.9
19	Constant Speed			2	6	2		6.0
20	Constant Speed		7	3				4.3
21	Deceleration					5	5	7.5
22	Idle				9	1		6.1
23	Constant Speed			2	5	3		6.1
24	Idle-Acceleration					2	8	7.8

TABLE 8B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 13, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Deceleration			8	2	2.2
2	Constant Speed		7	3		1.3
3	Blank	10				0
4	Idle-Acceleration			9	1	2.1
5	Idle			9	1	2.1
6	Constant Speed		9	1		1.1
7	Blank	10				0
8	Constant Speed		6	4		1.4
9	Deceleration			8	2	2.2
10	Idle-Acceleration			8	2	2.2
11	Blank	10				0
12	Constant Speed		1	9		1.9
13	Idle			7	3	2.3
14	Blank	10				0
15	Idle-Acceleration			9	1	2.1
16	Deceleration		1	7	2	2.1
17	Constant Speed		2	8		1.8
18	Idle		1	9		1.9
19	Constant Speed		2	8		1.8
20	Constant Speed		7	3		1.3
21	Deceleration			7	3	2.3
22	Idle			10		2.0
23	Constant Speed		1	9		1.9
24	Idle-Acceleration			7	3	2.3

TABLE 8C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 13, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Deceleration		3	7		1.7
2	Constant Speed		8	2		1.2
3	Blank	10				0
4	Idle-Acceleration			10		2.0
5	Idle		2	8		1.8
6	Constant Speed		9	1		1.1
7	Blank	10				0
8	Constant Speed	1	9			0.9
9	Deceleration		3	7		1.7
10	Idle-Acceleration			10		2.0
11	Blank	10				0
12	Constant Speed		3	7		1.7
13	Idle		2	7	1	1.9
14	Blank	10				0
15	Idle-Acceleration		1	9		1.9
16	Deceleration		1	9		1.9
17	Constant Speed		4	6		1.6
18	Idle			10		2.0
19	Constant Speed		4	6		1.6
20	Constant Speed		10			1.0
21	Deceleration		1	9		1.9
22	Idle		1	9		1.9
23	Constant Speed		4	6		1.6
24	Idle-Acceleration			8	2	2.2

TABLE 8D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 13, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

No.	Operating Condition	"A" Aromatic Responses 0	1	2	3	Average
1	Deceleration		8	2		1.2
2	Constant Speed		10			1.0
3	Blank	10				0
4	Idle-Acceleration	1	7	2		1.1
5	Idle		6	4		1.4
6	Constant Speed		10			1.0
7	Blank	10				0
8	Constant Speed		9	1		1.1
9	Deceleration		8	2		1.2
10	Idle-Acceleration		4	5	1	1.7
11	Blank	10				0
12	Constant Speed	1	7	2		1.1
13	Idle	2	5	3		1.1
14	Blank	10				0
15	Idle-Acceleration		8	2		1.2
16	Deceleration		5	5		1.5
17	Constant Speed	2	6	2		1.0
18	Idle		5	5		1.5
19	Constant Speed	1	7	2		1.1
20	Constant Speed	2	8			0.8
21	Deceleration		7	3		1.3
22	Idle	3	6	1		0.8
23	Constant Speed		8	2		1.2
24	Idle-Acceleration		4	6		1.6

TABLE 8E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676
Date: May 13, 1968

Operating Condition: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Deceleration		9	1	1.1
2	Constant Speed	9	1		0.1
3	Blank	10			0
4	Idle-Acceleration		7	3	1.3
5	Idle	1	5	4	1.3
6	Constant Speed	8	1	1	0.3
7	Blank	10			0
8	Constant Speed	5	5		0.5
9	Deceleration	1	5	4	1.3
10	Idle-Acceleration		5	5	1.5
11	Blank	10			0
12	Constant Speed	3	7		0.7
13	Idle		6	4	1.4
14	Blank	10			0
15	Idle-Acceleration	1	8	1	1.0
16	Deceleration	3	6	1	0.8
17	Constant Speed	5	4	1	0.6
18	Idle	2	7	1	0.9
19	Constant Speed	3	7		0.7
20	Constant Speed	8	2		0.2
21	Deceleration		8	2	1.2
22	Idle	1	9		0.9
23	Constant Speed	3	6	1	0.8
24	Idle-Acceleration		7	3	1.3

TABLE 9. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 14, 1968

Operating Conditions: See Table 1
Fuel: EM-65-F (Additive B)

Run No.*	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
		Average Panel Responses				
2	I. Constant Speed	4.0	1.0	1.0	0.5	0.1
8	" "	4.3	1.1	0.8	0.9	0.3
14	" "	4.9	1.3	1.0	1.0	0.6
22	" "	4.4	1.1	1.0	0.6	0.5
		4.4	1.1	1.0	0.8	0.4
1	II. Constant Speed	5.3	1.5	1.1	0.8	0.1
7	" "	5.0	1.4	1.1	0.5	0.3
10	" "	4.6	1.0	1.0	0.8	0.3
24	" "	5.3	1.5	1.4	0.9	0.4
		5.1	1.4	1.2	0.8	0.3
4	III. Idle	7.0	2.1	1.6	1.3	1.4
11	"	7.1	2.0	1.6	1.5	1.3
18	"	7.5	2.4	1.8	1.5	1.5
23	"	6.5	2.0	1.9	1.4	1.1
		7.0	2.1	1.7	1.4	1.3
6	IV. Idle-Acceleration	7.9	2.5	2.0	1.5	1.6
13	" "	7.8	2.5	2.0	1.3	1.5
17	" "	7.4	2.4	2.0	1.3	1.4
21	" "	7.6	2.4	1.9	1.4	1.5
		7.7	2.5	2.0	1.4	1.5
5	V. Deceleration	7.1	2.0	1.8	1.3	1.1
15	"	7.0	2.3	2.0	1.4	1.0
19	"	6.8	2.0	1.9	1.3	1.0
20	"	6.5	1.8	1.6	1.1	1.3
		6.9	2.0	1.8	1.3	1.1

---

*Runs 3, 9, 12 and 16 were conducted without exhaust sample.

TABLE 9A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: May 14, 1968

Operating Conditions: See Table 1
Fuel: EM-65-F (Additive B)

Run	Operating	"D" Diesel Composite Responses						
No.	Condition	0	4	5	6	7	8	Average
1	Constant Speed			6	2			5.3
2	Constant Speed		8					4.0
3	Blank	8						0
4	Idle					8		7.0
5	Deceleration				1	7		7.1
6	Idle-Acceleration					1	7	7.9
7	Constant Speed		2	4	2			5.0
8	Constant Speed		6	2				4.3
9	Blank	8						0
10	Constant Speed		3	5				4.6
11	Idle				1	7		7.1
12	Blank	8						0
13	Idle-Acceleration					2	6	7.8
14	Constant Speed		1	7				4.9
15	Deceleration				2	4	2	7.0
16	Blank	8						0
17	Idle-Acceleration					5	3	7.4
18	Idle					4	4	7.5
19	Deceleration				2	6		6.8
20	Deceleration			2	1	4	1	6.5
21	Idle-Acceleration				1	1	6	7.6
22	Constant Speed		5	3				4.4
23	Idle				4	4		6.5
24	Constant Speed		2	2	4			5.3

TABLE 9B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 14, 1968

Operating Conditions: See Table 1
Fuel: EM-65-F (Additive B)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Average
1	Constant Speed		4	4		1.5
2	Constant Speed		8			1.0
3	Blank	8				0
4	Idle			7	1	2.1
5	Deceleration			8		2.0
6	Idle-Acceleration			4	4	2.5
7	Constant Speed		5	3		1.4
8	Constant Speed		7	1		1.1
9	Blank	8				0
10	Constant Speed		8			1.0
11	Idle			8		2.0
12	Blank	8				0
13	Idle-Acceleration			4	4	2.5
14	Constant Speed		6	2		1.3
15	Deceleration			6	2	2.3
16	Blank	8				0
17	Idle-Acceleration			5	3	2.4
18	Idle			5	3	2.4
19	Deceleration			8		2.0
20	Deceleration		2	6		1.8
21	Idle-Acceleration			5	3	2.4
22	Constant Speed		7	1		1.1
23	Idle			8		2.0
24	Constant Speed		4	4		1.5

TABLE 9C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 14, 1968

Operating Conditions: See Table 1
Fuel: EM-65-F (Additive B)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Constant Speed		7	1		1.1
2	Constant Speed		8			1.0
3	Blank	8				0
4	Idle		3	5		1.6
5	Deceleration		2	6		1.8
6	Idle-Acceleration			8		2.0
7	Constant Speed		7	1		1.1
8	Constant Speed	2	6			0.8
9	Blank	8				0
10	Constant Speed		8			1.0
11	Idle		3	5		1.6
12	Blank	8				0
13	Idle-Acceleration		1	6	1	2.0
14	Constant Speed		8			1.0
15	Deceleration			8		2.0
16	Blank	8				0
17	Idle-Acceleration		1	6	1	2.0
18	Idle		2	6		1.8
19	Deceleration		1	7		1.9
20	Deceleration		3	5		1.6
21	Idle-Acceleration		1	7		1.9
22	Constant Speed		8			1.0
23	Idle		1	7		1.9
24	Constant Speed		5	3		1.4

TABLE 9D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 14, 1968

Operating Conditions: See Table 1
Fuel: EM-65-F (Additive B)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	2	6		0.8
2	Constant Speed	4	4		0.5
3	Blank	8			0
4	Idle		6	2	1.3
5	Deceleration		6	2	1.3
6	Idle-Acceleration		4	4	1.5
7	Constant Speed	4	4		0.5
8	Constant Speed	1	7		0.9
9	Blank	8			0
10	Constant Speed	2	6		0.8
11	Idle		4	4	1.5
12	Blank	8			0
13	Idle-Acceleration		6	2	1.3
14	Constant Speed		8		1.0
15	Deceleration		5	3	1.4
16	Blank	8			0
17	Idle-Acceleration		6	2	1.3
18	Idle		4	4	1.5
19	Deceleration		6	2	1.3
20	Deceleration		7	1	1.1
21	Idle-Acceleration		5	3	1.4
22	Constant Speed	3	5		0.6
23	Idle		5	3	1.4
24	Constant Speed	1	7		0.9

TABLE 9E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676	Operating Conditions: See Table 1
Date: May 14, 1968	Fuel: EM-65-F (Additive B)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	7	1		0.1
2	Constant Speed	7	1		0.1
3	Blank	8			0
4	Idle		5	3	1.4
5	Deceleration	1	5	2	1.1
6	Idle-Acceleration		3	5	1.6
7	Constant Speed	6	2		0.3
8	Constant Speed	6	2		0.3
9	Blank	8			0
10	Constant Speed	6	2		0.3
11	Idle		6	2	1.3
12	Blank	8			0
13	Idle-Acceleration		4	4	1.5
14	Constant Speed	3	5		0.6
15	Deceleration		8		1.0
16	Blank	8			0
17	Idle-Acceleration		5	3	1.4
18	Idle		4	4	1.5
19	Deceleration		8		1.0
20	Deceleration	1	4	3	1.3
21	Idle-Acceleration		4	4	1.5
22	Constant Speed	4	4		0.5
23	Idle		7	1	1.1
24	Constant Speed	5	3		0.4

TABLE 10. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 15, 1968

Operating Conditions: See Table 1
Fuel: EM-68-A (Additive C)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	I. Constant Speed	4.5	1.0	0.9	1.1	0.1
12	" "	5.0	1.1	0.9	1.1	0.3
17	" "	4.4	1.1	1.0	0.9	0
24	" "	4.6	1.5	1.3	0.8	0.4
		4.6	1.2	1.0	1.0	0.2
3	II. Constant Speed	4.6	1.3	1.1	0.5	0.3
8	" "	4.5	0.9	1.0	0.9	0
19	" "	5.0	1.5	1.3	0.8	0.4
22	" "	5.0	1.1	1.1	0.8	0.3
		4.8	1.2	1.1	0.8	0.3
5	III. Idle	7.4	2.0	2.0	1.6	1.3
10	"	6.6	1.9	1.4	1.4	1.3
13	"	7.4	2.3	2.0	1.5	1.4
20	"	5.4	1.8	0.9	1.0	0.5
		6.7	2.0	1.6	1.4	1.1
4	IV. Idle-Acceleration	7.5	2.5	1.9	1.4	1.1
6	" "	6.0	2.0	1.6	1.1	0.9
16	" "	7.8	2.5	2.1	1.4	1.6
23	" "	7.4	2.5	2.0	1.4	1.4
		7.2	2.4	1.9	1.3	1.3
2	V. Deceleration	6.0	2.0	1.4	1.1	0.9
9	"	6.3	1.9	1.6	1.4	1.1
14	"	5.8	1.9	1.6	0.9	0.8
21	"	7.5	2.4	2.0	1.6	1.1
		6.4	2.1	1.7	1.3	1.0

---

*Runs 7, 11, 15 and 18 were conducted without exhaust sample.

TABLE 10A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: May 15, 1968

Operating Conditions: See Table 1
Fuel: EM-68-A (Additive C)

Run	Operating	"D" Diesel Composite Responses						
No.	Condition	0	4	5	6	7	8	Average
1	Constant Speed		4	4				4.5
2	Deceleration				8			6.0
3	Constant Speed		5	1	2			4.6
4	Idle-Acceleration				1	2	5	7.5
5	Idle				2	5	1	7.4
6	Idle-Acceleration				8			6.0
7	Blank	8						0
8	Constant Speed		4	4				4.5
9	Deceleration			1	4	3		6.3
10	Idle				3	5		6.6
11	Blank	8						0
12	Constant Speed		1	6	1			5.0
13	Idle					5	3	7.4
14	Deceleration		1		7			5.8
15	Blank	8						0
16	Idle-Acceleration					2	6	7.8
17	Constant Speed		5	3				4.4
18	Blank	8						0
19	Constant Speed		1	6	1			5.0
20	Idle		1	3	4			5.4
21	Deceleration					4	4	7.5
22	Constant Speed		1	6	1			5.0
23	Idle-Acceleration					5	3	7.4
24	Constant Speed		1	5	2			4.6

TABLE 10B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Data: May 15, 1968

Operating Conditions: See Table 1
Fuel: EM-68-A (Additive C)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed	1	6	1		1.0
2	Deceleration			8		2.0
3	Constant Speed		6	2		1.3
4	Idle-Acceleration			4	4	2.5
5	Idle			8		2.0
6	Idle-Acceleration			8		2.0
7	Blank	8				0
8	Constant Speed	1	7			0.9
9	Deceleration		1	7		1.9
10	Idle		1	7		1.9
11	Blank	8				0
12	Constant Speed		7	1		1.1
13	Idle			6	2	2.3
14	Deceleration		1	7		1.9
15	Blank	8				0
16	Idle-Acceleration			4	4	2.5
17	Constant Speed		7	1		1.1
18	Blank	8				0
19	Constant Speed		4	4		1.5
20	Idle		2	6		1.8
21	Deceleration			5	3	2.4
22	Constant Speed		7	1		1.1
23	Idle-Acceleration			4	4	2.5
24	Constant Speed		4	4		1.5

TABLE 10C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 15, 1968

Operating Conditions: See Table 1
Fuel: EM-68-A (Additive C)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Constant Speed	1	7			0.9
2	Deceleration		5	3		1.4
3	Constant Speed		7	1		1.1
4	Idle-Acceleration		1	7		1.9
5	Idle			8		2.0
6	Idle-Acceleration		3	5		1.6
7	Blank	8				0
8	Constant Speed		8			1.0
9	Deceleration		3	5		1.6
10	Idle	1	3	4		1.4
11	Blank	8				0
12	Constant Speed	1	7			0.9
13	Idle		1	6	1	2.0
14	Deceleration		3	5		1.6
15	Blank	8				0
16	Idle-Acceleration			7	1	2.1
17	Constant Speed		8			1.0
18	Blank	8				0
19	Constant Speed		6	2		1.3
20	Idle	1	7			0.9
21	Deceleration			8		2.0
22	Constant Speed		7	1		1.1
23	Idle-Acceleration			8		2.0
24	Constant Speed		6	2		1.3

TABLE 10D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 15, 1968

Operating Conditions: See Table 1
Fuel: EM-68-A (Additive C)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed		7	1	1.1
2	Deceleration		7	1	1.1
3	Constant Speed	4	4		0.5
4	Idle-Acceleration		5	3	1.4
5	Idle		3	5	1.6
6	Idle-Acceleration		7	1	1.1
7	Blank	8			0
8	Constant Speed	1	7		0.9
9	Deceleration		5	3	1.4
10	Idle	1	3	4	1.4
11	Blank	8			0
12	Constant Speed		7	1	1.1
13	Idle		4	4	1.5
14	Deceleration	1	7		0.9
15	Blank	8			0
16	Idle-Acceleration		5	3	1.4
17	Constant Speed	1	7		0.9
18	Blank	8			0
19	Constant Speed	3	4	1	0.8
20	Idle		8		1.0
21	Deceleration		3	5	1.6
22	Constant Speed	2	6		0.8
23	Idle-Acceleration		5	3	1.4
24	Constant Speed	2	6		0.8

TABLE 10E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676
Date: May 15, 1968

Operating Conditions: See Table 1
Fuel: EM-68-A (Additive C)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	7	1		0.1
2	Deceleration	1	7		0.9
3	Constant Speed	6	2		0.3
4	Idle-Acceleration		7	1	1.1
5	Idle		6	2	1.3
6	Idle-Acceleration	1	7		0.9
7	Blank	8			0
8	Constant Speed	8			0
9	Deceleration		7	1	1.1
10	Idle		6	2	1.3
11	Blank	8			0
12	Constant Speed	6	2		0.3
13	Idle		5	3	1.4
14	Deceleration	2	6		0.8
15	Blank	8			0
16	Idle-Acceleration		3	5	1.6
17	Constant Speed	8			0
18	Blank	8			0
19	Constant Speed	5	3		0.4
20	Idle	4	4		0.5
21	Deceleration		7	1	1.1
22	Constant Speed	6	2		0.3
23	Idle-Acceleration		5	3	1.4
24	Constant Speed	5	3		0.4

TABLE 11. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 16, 1968

Operating Conditions: See Table 1
Fuel: EM-69-F (Additive D)

Run		Average Panel Responses				
No.*	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
8	I. Constant Speed	5.7	1.7	1.7	1.0	0.3
11	" "	5.1	2.0	1.1	1.0	0.3
20	" "	5.7	1.9	1.6	1.0	0.7
24	" "	5.0	1.3	1.0	1.0	0.4
		5.4	1.7	1.3	1.0	0.4
1	II. Constant Speed	5.9	1.6	1.6	1.0	0.7
5	" "	5.1	1.6	1.1	1.0	0.1
17	" "	6.0	1.9	1.6	1.1	1.1
21	" "	5.1	1.4	1.1	0.9	0.6
		5.5	1.6	1.4	1.0	0.6
3	III. Idle	6.6	2.0	2.0	1.0	1.6
6	"	6.1	2.0	1.9	1.3	0.6
14	"	6.4	2.0	1.6	1.7	0.7
16	"	7.0	2.0	1.9	1.1	1.3
		6.5	2.0	1.9	1.3	1.1
2	IV. Idle-Acceleration	7.4	2.3	2.0	1.3	1.6
9	" "	7.9	2.6	1.9	1.6	1.6
19	" "	7.3	2.4	2.0	1.3	1.3
22	" "	7.7	2.6	2.0	1.1	1.6
		7.6	2.5	2.0	1.3	1.5
4	V. Deceleration	7.1	2.3	1.9	1.3	1.6
10	"	6.7	2.0	1.9	1.3	1.0
13	"	7.1	2.3	1.9	1.4	1.4
23	"	6.9	2.0	1.9	1.1	1.6
		7.0	2.2	1.9	1.3	1.4

---

*Runs 7, 12, 15 and 18 were conducted without exhaust sample.

TABLE 11A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: May 16, 1968

Operating Conditions: See Table 1
Fuel: EM-69-F (Additive D)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	4	5	6	7	8	Average
1	Constant Speed			3	2	2		5.9
2	Idle-Acceleration					4	3	7.4
3	Idle				3	4		6.6
4	Deceleration				1	4	2	7.1
5	Constant Speed			6	1			5.1
6	Idle				6	1		6.1
7	Blank	7						0
8	Constant Speed			2	5			5.7
9	Idle-Acceleration					1	6	7.9
10	Deceleration				2	5		6.7
11	Constant Speed			6	1			5.1
12	Blank	7						0
13	Deceleration				2	2	3	7.1
14	Idle				4	3		6.4
15	Blank	7						0
16	Idle					7		7.0
17	Constant Speed		1		4	2		6.0
18	Blank	7						0
19	Idle-Acceleration					5	2	7.3
20	Constant Speed			2	5			5.7
21	Constant Speed		1	4	2			5.1
22	Idle-Acceleration				1		6	7.7
23	Deceleration				1	6		6.9
24	Constant Speed		1	5	1			5.0

TABLE 11B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 16, 1968

Operating Conditions: See Table 1
Fuel: EM-69-F (Additive D)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		3	4		1.6
2	Idle-Acceleration			5	2	2.3
3	Idle			7		2.0
4	Deceleration			5	2	2.3
5	Constant Speed		3	4		1.6
6	Idle			7		2.0
7	Blank	7				0
8	Constant Speed		2	5		1.7
9	Idle-Acceleration			3	4	2.6
10	Deceleration			7		2.0
11	Constant Speed		3	4		1.6
12	Blank	7				0
13	Deceleration			5	2	2.3
14	Idle			7		2.0
15	Blank	7				0
16	Idle			7		2.0
17	Constant Speed		1	6		1.9
18	Blank	7				0
19	Idle-Acceleration			4	3	2.4
20	Constant Speed		1	6		1.9
21	Constant Speed		4	3		1.4
22	Idle-Acceleration			3	4	2.6
23	Deceleration			7		2.0
24	Constant Speed		5	2		1.3

TABLE 11C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 16, 1968

Operating Conditions: See Table 1
Fuel: EM-69-F (Additive D)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Constant Speed		3	4		1.6
2	Idle-Acceleration			7		2.0
3	Idle			7		2.0
4	Deceleration		1	6		1.9
5	Constant Speed		6	1		1.1
6	Idle		1	6		1.9
7	Blank	7				0
8	Constant Speed		2	5		1.7
9	Idle-Acceleration		1	6		1.9
10	Deceleration		1	6		1.9
11	Constant Speed		6	1		1.1
12	Blank	7				0
13	Deceleration		1	6		1.9
14	Idle		3	4		1.6
15	Blank	7				0
16	Idle		1	6		1.9
17	Constant Speed		3	4		1.6
18	Blank	7				0
19	Idle-Acceleration			7		2.0
20	Constant Speed		3	4		1.6
21	Constant Speed		6	1		1.1
22	Idle-Acceleration		1	5	1	2.0
23	Deceleration		1	6		1.9
24	Constant Speed		7			1.0

TABLE 11D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 16, 1968

Operating Conditions: See Table 1
Fuel: EM-69-F (Additive D)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Average
1	Constant Speed	1	5	1	1.0
2	Idle-Acceleration		5	2	1.3
3	Idle	1	5	1	1.0
4	Deceleration		5	2	1.3
5	Constant Speed		7		1.0
6	Idle		5	2	1.3
7	Blank	7			0
8	Constant Speed	1	5	1	1.0
9	Idle-Acceleration		3	4	1.6
10	Deceleration		5	2	1.3
11	Constant Speed	1	5	1	1.0
12	Blank	7			0
13	Deceleration		4	3	1.4
14	Idle		2	5	1.7
15	Blank	7			0
16	Idle		6	1	1.1
17	Constant Speed		6	1	1.1
18	Blank	7			0
19	Idle-Acceleration		5	2	1.3
20	Constant Speed		7		1.0
21	Constant Speed	1	6		0.9
22	Idle-Acceleration	1	4	2	1.1
23	Deceleration		6	1	1.1
24	Constant Speed		7		1.0

TABLE 11E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676
Date: May 16, 1968

Operating Conditions: See Table 1
Fuel: EM-69-F (Additive D)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	2	5		0.7
2	Idle-Acceleration		3	4	1.6
3	Idle		3	4	1.6
4	Deceleration		3	4	1.6
5	Constant Speed	6	1		0.1
6	Idle	3	4		0.6
7	Blank	7			0
8	Constant Speed	5	2		0.3
9	Idle-Acceleration		3	4	1.6
10	Deceleration		7		1.0
11	Constant Speed	5	2		0.3
12	Blank	7			0
13	Deceleration		4	3	1.4
14	Idle	2	5		0.7
15	Blank	7			0
16	Idle		5	2	1.3
17	Constant Speed	1	4	2	1.1
18	Blank	7			0
19	Idle-Acceleration		5	2	1.3
20	Constant Speed	2	5		0.7
21	Constant Speed	4	2	1	0.6
22	Idle-Acceleration		3	4	1.6
23	Deceleration		3	4	1.6
24	Constant Speed	4	3		0.4

TABLE 12. VEHICLE ODOR EVALUATION SUMMARY

(Initial Odor Additive Screening)

Vehicle: Bus 676
Date: May 17, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

		Average Panel Responses				
Run No. *	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	I. Constant Speed	4.3	1.0	1.0	1.0	0.1
7	" "	4.4	1.1	1.0	0.9	0.1
13	" "	5.8	1.5	1.5	1.0	0.5
18	" "	5.9	1.9	1.6	1.0	0.6
		5.1	1.5	1.3	1.0	0.3
2	II. Constant Speed	5.1	1.5	1.0	0.9	0.4
11	" "	6.1	1.9	1.6	1.4	0.9
16	" "	6.1	1.9	1.6	1.3	0.8
22	" "	5.0	1.1	1.1	1.1	0
		5.6	1.6	1.3	1.2	0.5
6	III. Idle	5.6	1.8	1.3	1.1	0.6
8	"	7.1	2.3	1.8	1.1	1.3
19	"	7.0	2.4	2.0	1.8	1.3
24	"	6.4	1.9	2.0	1.3	1.1
		6.5	2.1	1.8	1.3	1.1
4	IV. Idle-Acceleration	7.6	2.5	2.3	1.3	1.9
12	" "	7.5	2.5	2.1	1.6	1.3
17	" "	8.1	2.5	2.1	1.6	1.8
23	" "	7.5	2.5	2.0	1.3	1.6
		7.7	2.5	2.1	1.5	1.7
1	V. Deceleration	7.3	2.3	2.0	1.3	1.4
9	"	5.9	1.8	1.5	1.1	0.8
14	"	7.0	2.1	2.1	1.3	1.3
21	"	6.6	2.1	1.8	1.4	1.0
		6.7	2.1	1.9	1.3	1.1

---

*Runs 5, 10, 15 and 20 were conducted without exhaust sample.

TABLE 12A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: May 17, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run	Operating	"D" Diesel Composite Responses							
No.	Condition	0	4	5	6	7	8	9	Average
1	Deceleration				1	4	3		7.3
2	Constant Speed		1	5	2				5.1
3	Constant Speed		6	2					4.3
4	Idle-Acceleration					3	5		7.6
5	Blank	8							0
6	Idle			3	5				5.6
7	Constant Speed		5	3					4.4
8	Idle				2	3	3		7.1
9	Deceleration			3	3	2			5.9
10	Blank	8							0
11	Constant Speed			2	3	3			6.1
12	Idle-Acceleration					4	4		7.5
13	Constant Speed			2	6				5.8
14	Deceleration					8			7.0
15	Blank	8							0
16	Constant Speed				7	1			6.1
17	Idle-Acceleration						7	1	8.1
18	Constant Speed			2	5	1			5.9
19	Idle			1		5	2		7.0
20	Blank	8							0
21	Deceleration			1	1	6			6.6
22	Constant Speed			8					5.0
23	Idle-Acceleration					4	4		7.5
24	Idle			1	3	4			6.4

TABLE 12B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: May 17, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Deceleration			6	2	2.3
2	Constant Speed		4	4		1.5
3	Constant Speed		8			1.0
4	Idle-Acceleration			4	4	2.5
5	Blank	8				0
6	Idle		2	6		1.8
7	Constant Speed		7	1		1.1
8	Idle			6	2	2.3
9	Deceleration		2	6		1.8
10	Blank	8				0
11	Constant Speed		1	7		1.9
12	Idle-Acceleration			4	4	2.5
13	Constant Speed		1	7		1.9
14	Deceleration			7	1	2.1
15	Blank	8				0
16	Constant Speed		1	7		1.9
17	Idle-Acceleration			4	4	2.5
18	Constant Speed		1	7		1.9
19	Idle		1	3	4	2.4
20	Blank	8				0
21	Deceleration		1	5	2	2.1
22	Constant Speed		7	1		1.1
23	Idle-Acceleration			4	4	2.5
24	Idle		1	7		1.9

TABLE 12C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 676
Date: May 17, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Deceleration		1	6	1	2.0
2	Constant Speed		8			1.0
3	Constant Speed		8			1.0
4	Idle-Acceleration			6	2	2.3
5	Blank	8				0
6	Idle		6	2		1.3
7	Constant Speed		8			1.0
8	Idle		2	6		1.8
9	Deceleration		4	4		1.5
10	Blank	8				0
11	Constant Speed		4	3	1	1.6
12	Idle-Acceleration			7	1	2.1
13	Constant Speed		4	4		1.5
14	Deceleration			7	1	2.1
15	Blank	8				0
16	Constant Speed		3	5		1.6
17	Idle-Acceleration			7	1	2.1
18	Constant Speed		3	5		1.6
19	Idle		1	6	1	2.0
20	Blank	8				0
21	Deceleration		2	6		1.8
22	Constant Speed		7	1		1.1
23	Idle-Acceleration			8		2.0
24	Idle		2	6		1.8

TABLE 12D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 676
Date: May 17, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	3	Average
1	Deceleration		6	2		1.3
2	Constant Speed	1	7			0.9
3	Constant Speed	1	6	1		1.0
4	Idle-Acceleration		6	2		1.3
5	Blank	8				0
6	Idle	1	5	2		1.1
7	Constant Speed	2	5	1		0.9
8	Idle	1	5	2		1.1
9	Deceleration	1	5	2		1.1
10	Blank	8				0
11	Constant Speed		6	1	1	1.4
12	Idle-Acceleration		5	1	2	1.6
13	Constant Speed	1	6	1		1.0
14	Deceleration		6	2		1.3
15	Blank	8				0
16	Constant Speed		6	2		1.3
17	Idle-Acceleration		5	1	2	1.6
18	Constant Speed		8			1.0
19	Idle		2	6		1.8
20	Blank	8				0
21	Deceleration	1	3	4		1.4
22	Constant Speed		7	1		1.1
23	Idle-Acceleration		6	2		1.3
24	Idle		6	2		1.3

TABLE 12E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 676
Date: May 17, 1968

Operating Conditions: See Table 1
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Deceleration		5	3	1.4
2	Constant Speed	5	3		0.4
3	Constant Speed	7	1		0.1
4	Idle-Acceleration		1	7	1.9
5	Blank	8			0
6	Idle	3	5		0.6
7	Constant Speed	7	1		0.1
8	Idle	1	4	3	1.3
9	Deceleration	2	6		0.8
10	Blank	8			0
11	Constant Speed	2	5	1	0.9
12	Idle-Acceleration	1	4	3	1.3
13	Constant Speed	4	4		0.5
14	Deceleration		6	2	1.3
15	Blank	8			0
16	Constant Speed	3	4	1	0.8
17	Idle-Acceleration		2	6	1.8
18	Constant Speed	3	5		0.6
19	Idle	1	4	3	1.3
20	Blank	8			0
21	Deceleration	2	4	2	1.0
22	Constant Speed	8			0
23	Idle-Acceleration		3	5	1.6
24	Idle	1	5	2	1.1

TABLE 13. PROCEDURE FOR DETERMINING STATISTICAL DIFFERENCE OF ODOR AND EMISSIONS FROM CATALYTIC AND STOCK MUFFLERS

Applicability: GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.

Statistical Method: The "U" statistic test (Mann-Whitney test), which was used to make the evaluations, is described by the following expression:

$$U_s = mn + \frac{m(m+1)}{2} - T$$

where

m - number of readings in the smaller set

n - number of readings in the larger set

for

$m \neq n$, T is the sum of the relative rankings of the smaller set

$m = n$, T is the sum of the set which gives the larger relative ranking

For purposes of determining whether the catalytic muffler is statistically different from the stock muffler, it has been determined by SwRI statisticians that the "U_s" statistic should be either 0, 1, or 2, where m equals n; that is, the number of repeat measurements is the same for the catalytic and noncatalytic sets of data. Where an uneven number of data has been obtained such that m does not equal the n, the most common occurrence being m equal to 3 and n equal to 4, the statistical difference has been placed where the "U_s" statistic is equal to 0 or 1.

Procedure:

(1) Given is a set of actual responses of the overall "D" diesel composite for a 20 mph, constant speed, cruise condition:

Stock	Catalytic
6.8	4.4
6.4	6.3
6.1	4.4
6.0	5.8

(2) Since the number of responses are the same for both the catalytic muffler and stock muffler, designate the catalytic muffler data as set "n" and stock muffler data as set "m."

(3) The four values of set "m" and the four values of set "n" are ranked according to the least intense response first to the most intense response in the eight position.

Relative Ranking	"D" Response
1	4.4 - Catalytic
2	4.4 - Catalytic
3	5.8 - Catalytic
4	6.0 - Stock
5	6.1 - Stock
6	6.3 - Catalytic
7	6.4 - Stock
8	6.8 - Stock

(4) Since the set "m" and "n" are of equal number, the largest sum (T) of the relative rankings will be used to compute U_s.

Set "m" (Stock)	Set "n" (Catalytic)
4	1
5	2
7	3
8	6
24	12

(5) Given is the equation for the "U_s" statistic. Evaluating this equation gives a U_s value of two. By definition of the "U" test statistic with the sets $m = n - 4$, a statistical difference is indicated:

$$U_s = mn + \frac{m(m+1)}{2} - T$$

$$U_s = 26 - 24$$

$$U_s = 2$$

TABLE 14. "U" TEST FOR STATISTICAL DIFFERENCE BETWEEN ODOR RATINGS NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE A

Vehicle: Bus 676
Engine: Detroit Diesel 6V-71

Date: May 10, 1968 Additive A + EM-3A-F
May 17, 1968 EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality					Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I	1	S*	S	A**	A	S	IV	1	A	A	A	A	A
20 mph	2	S**	A**	A**	A**	S	Idle-	2	A	A	A**	A	A
40 hp	3	A**	A**	S**	A**	A	Acceleration	3	A	A	A**	S	S
	4	A**	S**	S**	S**	A		4	S	A	A**	S	S
	5	A†	A	A	A**	S		5	S	S	S**	A**	A
	6	A	A	A	S**	A**		6	S	S	S	A**	A
	7	S	S	S	S**	S**		7	A	S	S	S**	S
	8	S	S	S	S**	A		8	S	S	S	S**	S
	U_s‡	7	7	6	2	4.5		U_s	3	0	1.5	8	4
II	1	A	A	A**	A**	S	V	1	S	A	S	A	S
40 mph	2	A	A	A**	A**	A	Deceleration	2	S	A**	A	A**	A
40 hp	3	A**	A**	S**	S**	A		3	A	A**	A**	A**	S**
	4	S**	A**	A**	A	A		4	A	S**	A**	S**	A**
	5	S	S**	A**	A**	S		5	A	A	S**	S**	A
	6	A	S	S**	S**	A**		6	S	S	A	A**	S
	7	S	S	S	S	S**		7	A	S	S	S**	S
	8	S	S	S	S	S		8	S	S	S	S	A
	U_s	2.5	1	4	3	5.5		U_s	7	1	4	2	7.5
III	1	S	A**	S	A**	S							
Idle	2	A	S**	A	S**	A							
	3	A	A**	A	S**	A							
	4	A**	A**	A	A**	A							
	5	S**	S**	A	A**	A**							
	6	A	A	S	S**	S**							
	7	S	S	S	A	S							
	8	S	S	S	S	S							
	U_s	5	4.5	4	7	4.5							

---

*"S" stands for EM-3A-F (No. 1 diesel) untreated fuel.

†"A" stands for EM-3A-F treated with Additive A.

‡U_s must equal 0, 1, or 2 to show significant difference for 8 relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 15. "U" TEST FOR STATISTICAL DIFFERENCE BETWEEN ODOR RATINGS NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE B

Vehicle: Bus 676
Engine: Detroit Diesel 6V-71E

Date: May 14, 1968 Additive B + EM-3A-F
May 17, 1968 EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality "D"	Odor Quality "B"	Odor Quality "O"	Odor Quality "A"	Odor Quality "P"
I	1	B†	B**	B	B	B**
20 mph	2	B**	S**	B**	B	S**
40 hp	3	S**	B**	B**	B**	S**
	4	B**	B**	B**	S**	B
	5	S**	S**	S**	B**	B**
	6	B	B	S**	S**	S**
	7	S*	S	S	S**	B**
	8	S	S	S	S**	S**
	U_s‡	3.5	4.5	3	3	8
II	1	B	B	B**	B	S
40 mph	2	B**	S	S**	B	B
40 hp	3	S**	B	B**	B	B
	4	S	B**	B**	B**	B
	5	B	B**	S**	S**	B**
	6	B	S**	B	S	S**
	7	S	S	S	S	S
	8	S	S	S	S	S
	U_s	4.5	4	5	0.5	4.5
III	1	S	S	S	S	S
Idle	2	S	S	B	S	B**
	3	B	B	B	B**	S**
	4	B**	B	B**	S**	B**
	5	S**	B	S**	B	S**
	6	B**	S	B	B	S**
	7	S**	B**	S	B	B
	8	B	S**	S	S	B
	U_s	4.5	7	5	4.5	3.5

Operating Conditions	Relative Ranking	Odor Quality "D"	Odor Quality "B"	Odor Quality "O"	Odor Quality "A"	Odor Quality "P"
IV	1	B	B	B	B**	S
Idle-	2	S	B	B**	B**	B
Acceleration	3	S	B**	B**	S**	B
	4	B**	B**	B**	S**	B
	5	S**	S**	S**	B	B**
	6	B	S**	S	B	S**
	7	B	S**	S	S	S
	8	S	S**	S	S	S
	U_s	7.5	4	1.5	6	4
V	1	S	B**	S	B**	S
Deceleration	2	B	S**	B	S**	B
	3	S	B	B**	B**	B**
	4	B	B	S**	B**	S**
	5	B**	S	B	S**	B
	6	S**	S	B**	S**	B**
	7	B	B**	S**	B**	S**
	8	S	S**	S	S**	S
	U_s	8	5.5	6.5	5.5	6

---

*"S" stands for EM-3A-F (No. 1 diesel) untreated fuel.

†"B" stands for EM-3A-F treated with Additive B.

‡U_s must equal 0, 1, or 2 to show significant difference for 8 relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 16. "U" TEST FOR STATISTICAL DIFFERENCE BETWEEN ODOR RATINGS NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE C

Vehicle: Bus 676
Engine: Detroit Diesel 6V-71E

Date: May 15, 1968 Additive C + EM-3A-F
May 17, 1968 EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
I	1	S*	C**	C	C	C
20 mph	2	C**	S**	C	C**	C**
40 hp	3	S**	C**	S**	S**	S**
	4	C†	C**	C**	S	S**
	5	C	S**	S**	S	C
	6	C	C	C	S	C
	7	S	S	S	C	S
	8	S	S	S	C	S
	U_s‡	7.5	5.5	3	7.5	5
II	1	C	C	C**	C	C**
40 mph	2	C	C**	S**	C	S**
40 hp	3	C**	S**	C**	C	C
	4	C**	C	C**	C**	C
	5	S**	C**	S**	S**	C**
	6	S	S**	C	S	S**
	7	S	S	S	S	S
	8	S	S	S	S	S
	U_s	1	3	5.5	0.5	4
III	1	C	C**	C	C	C
Idle	2	S	S**	S	S	S
	3	S	C**	C	S	S
	4	C	S**	S	S	C**
	5	S	C	C**	C	C**
	6	S	C**	C**	C	S**
	7	C	S**	S**	C	S**
	8	C	S	S**	S	C
	U_s	6	6.5	7	7	6
IV	1	C	C	C	C	C
Idle-	2	C	C**	C	S	C
Acceleration	3	C**	C**	C**	S	S
	4	S**	C**	S**	C	C
	5	S**	S**	C**	C	C**
	6	S	S**	S**	C	S**
	7	C	S**	S**	S	S
	8	S	S**	S	S	S
	U_s	4	6	2.5	6	2.5
V	1	C	S	C	C	C**
Deceleration	2	S	C	S	C**	S**
	3	C	C	C	S**	C
	4	C	C	C	S	S
	5	S	S	S	S	C
	6	S	S	C**	C**	C
	7	S	S	S**	S**	S
	8	C	C	S	C	S
	U_s	6	7	4.5	8	5.5

---

*"S" stands for EM-3A-F (No. 1 diesel) untreated fuel.
†"C" stands for EM-3A-F treated with Additive C.
‡U_s must equal 0, 1, or 2 to show significant differences for 8 relative rankings.
**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 17. "U" TEST FOR STATISTICAL DIFFERENCE BETWEEN ODOR RATINGS NO. 1 DIESEL FUEL WITH AND WITHOUT ADDITIVE D

Vehicle: Bus 676
Engine: Detroit Diesel 6V-71E

Date: May 16, 1968 Additive D + EM-3A-F
May 17, 1968 EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality					Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I	1	S	S	D**	S	S	IV	1	D	D	D	D	D**
20 mph	2	S	S	S**	D**	S	Idle-	2	D	D	D**	D**	S**
40 hp	3	D	D	S**	D**	S	Acceleration	3	S	S	D**	D**	D**
	4	D	D	D	D**	D		4	S	S	D**	S**	D**
	5	D	D**	S	D**	D		5	S	S	S**	S**	D**
	6	D	S**	D**	S**	S		6	D	S	S	D**	S**
	7	S	S**	S**	S**	S		7	D	D	S	S**	S
	8	S	D	D	S**	D		8	S	D	S	S**	S
	U_s‡	8	3	6	6	6		U_s	6	8	1.5	4	5
II	1	S	S	S	D**	S	V	1	S	S	S	D**	S
40 mph	2	D**	D	D**	S**	D	Deceleration	2	S	D	S	S**	D**
40 hp	3	D**	S	D**	D	S		3	D	D	D	D**	S**
	4	S**	D	S**	D	D		4	D	S	D	D**	S
	5	D	D	D**	D**	D		5	S	S	D	S**	D**
	6	D	D**	D**	S**	S		6	D	S**	D	S**	S**
	7	S	S**	S**	S	S		7	D	D**	S	D**	D
	8	S	S**	S**	S	D		8	S	D**	S	S**	D
	U_s	7	7	7	4	7		U_s	6	7	8	7.5	3
III	1	S	S	S	D	D**							
Idle	2	D	S	D	D**	S**							
	3	D**	D	S	S**	D							
	4	S**	D	D	S**	S							
	5	D	D	D	D**	D**							
	6	D**	D	D**	S**	S**							
	7	S**	S	S**	D	S**							
	8	S	S	S**	S	D							
	U_s	6	8	7	4.5	7.5							

---

*"S" stands for EM-3A-F (No. 1 diesel) untreated fuel.
†"D" stands for EM-3A-F treated with Additive D.
‡U_s must equal 0, 1, or 2 to show significant difference for 8 relative rankings.
**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 18. "U" TEST FOR STATISTICAL DIFFERENCE BETWEEN ODOR RATINGS MOST REPRESENTATIVE BASELINE (5/17/68) VS BASE OPERATION OF 5/9/68 ALL EM-3A-F (NO. 1 DIESEL) FUEL

Vehicle: Bus 676

Engine: Detroit Diesel 6V-71E

Operating Conditions	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
I	1	S*	S	S	S	S
20 mph	2	S	S	S	S	S
40 hp	3	Q†	Q	Q	S	Q
	4	Q	Q	Q	S	Q
	5	Q	Q	Q	Q	Q
	6	Q**	Q	Q	Q	Q
	7	S**	S	S	Q	S
	8	S	S	S	Q	S
	U_s‡	7.5	8	8	0	8
II	1	S	S	S	S	Q
40 mph	2	S	Q	S	S**	Q**
40 hp	3	Q	Q	Q	Q**	S**
	4	Q	S	Q	Q**	S
	5	Q	Q	Q	Q**	S
	6	Q	Q	Q	S**	S
	7	S	S	S	Q**	Q
	8	S	S	S	S	Q
	U_s	8	6	8	7	7.5
III	1	S	S	S	S	S
Idle	2	S	S	Q	S	Q
	3	Q	Q	Q	Q	Q
	4	Q	Q	Q**	S	Q
	5	Q	Q	S**	Q	S**
	6	Q**	Q	Q**	Q	Q**
	7	S**	S	S	S**	S
	8	S	S	S	Q**	S
	U_s	7.5	8	5	4.5	4.5
IV	1	S	S	S	Q	Q
Idle-	2	S	S	S	Q**	Q
Acceleration	3	Q	S	Q	S**	S**
	4	Q	Q	S**	Q**	Q**
	5	S**	Q	S**	S**	Q**
	6	Q**	Q	Q**	Q	S
	7	S	Q	Q**	S	S
	8	Q	S	Q	S	S
	U_s	5.5	4	4	4	1
V	1	S	S	Q	S	Q**
Deceleration	2	S	Q	Q	S	S**
	3	Q	Q	S	S	Q**
	4	S**	S	Q	S**	S**
	5	Q**	S	S	Q**	Q
	6	S	S**	Q	Q**	S**
	7	Q	Q**	S	Q	Q**
	8	Q	Q	S	Q	S
	U_s	3.5	6.5	3	1	7

---

*"S" stands for 5/17/68 baseline operation.

†"Q" stands for 5/9/68 baseline operation.

‡U_s must equal 0, 1, or 2 to show significant difference for 8 relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 19. "U" TEST FOR STATISTICAL DIFFERENCE BETWEEN ODOR RATINGS MOST REPRESENTATIVE BASELINE (5/17/68) VS BASE OPERATION OF 5/13/68

Vehicle: Bus 676

Engine: Detroit Diesel 6V-71 E

Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"
I	1	R**	S	R	R	S
20 mph	2	S**	S**	R**	S	S
40 hp	3	R**	R**	S**	S	R
	4	S	R	S**	S**	R
	5	R	R	R	S**	R**
	6	S	S**	S	R**	S**
	7	S**	S**	S	R	S
	8	R**	R**	R	R	S
	U_s	6.5	7.5	7	5.5	5.5
II	1	R	S	S	S	S
40 mph	2	S	R	S	R	R
40 hp	3	S	S	R	R	S
	4	R	R	R**	R**	R
	5	R	R	R**	S**	R
	6	S**	S**	S**	R	R**
	7	S**	S**	S**	S	S**
	8	R**	R**	R**	S	S
	U_s	7	8	5	5.5	7.5
III	1	S	S	S	R	S
Idle	2	R	S**	S**	S**	R
	3	S	R**	R**	S**	R
	4	R	R	R	R**	S
	5	R	R	R	S	S**
	6	R	R**	S**	R	S**
	7	S	S**	S**	R	R**
	8	S	S	R**	S	R
	U_s	7	8	7.5	7	7
IV	1	R	R	R	R	R
Idle-	2	R	R	R**	R	R**
Acceleration	3	R	R	S**	S	S**
	4	S	R	R**	S	R**
	5	S	S	S	R**	R
	6	S	S	S	S**	S
	7	R	S	R	S**	S
	8	S	S	S	R	S
	U_s	3	0	4	7	2
V	1	S	S	R	S	S**
Deceleration	2	S	S**	R	R	R**
	3	R	S**	R	R	S
	4	R	R**	S**	S**	R
	5	S**	R	R**	S**	R
	6	R**	R	S	R**	S**
	7	S	R**	S	S	R**
	8	R	S**	S	R	S
	U_s	5.5	4.5	0.5	8	7

---

*"S" stands for 5/17/68 baseline operation.

†"R" stands for 5/13/68 baseline operation.

‡U_s must equal 0, 1, or 2 to show significant difference for 8 relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

ODOR ADDITIVE FLEET TEST RESULTS

Smoke Procedures

Chemistry Procedures

INITIAL INSPECTION

Preceding page blank

TABLE 20. SMOKE EVALUATION CONDITIONS EMPLOYED DURING EVALUATION OF ODOR ADDITIVE

Vehicle Data:	GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. On vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is not operated.
Measurement Method:	U.S. Public Health Service full-flow light extinction type smokemeter.
Inertia:	Full inertia simulation via SwRI system.

OPERATING CONDITIONS

Type Operation	Vehicle Speed, mph	Transmission Drive Range	Vehicle Load, hp	For Details, Refer to:
A. Constant Speed	20	High	Open rack	Table 21
B. Constant Speed	25	High	Open rack	Table 21
C. Constant Speed	30	High	Open rack	Table 21
D. Constant Speed	35	High	Open rack	Table 21
E. Idle-Acceleration	0-40	--	40 hp at 30 mph	Table 22

TABLE 21. CONSTANT SPEED DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.
Measurement Method:	U.S. Public Health Service full-flow light extinction type smokemeter.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator, if used, removed.
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speeds and Loads:	The following are to be run:

Vehicle Speed, mph	Transmission Drive Range	Engine Speed, rpm approx	Power Load
20	High	900	Open rack
25	High	1000	Open rack
30	High	1200	Open rack
35	High	1400	Open rack

Procedure:

(1) Zero potentiometric recorder and 100% adjust smokemeter with engine "off" using 2 SCFM of purge air to collimating tubes.

(2) Start engine and accelerate through upshift and load vehicle back to 20 mph at open-rack maximum horsepower. On those vehicles which tend to downshift at 20 mph constant speed, operate as near 20 mph as possible. After 30 sec of stable operation, note the average maximum smokemeter reading.

(3) Release some load in the water brake dynamometer, and allow vehicle speed to increase to 25 mph. After 30 sec of stable operation, note the average maximum smokemeter reading.

(4) Using the procedure in item (3), similarly operate at 30 to 35 mph.

(5) Repeat items (1) through (4) two times.

TABLE 22. IDLE-ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	**GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.**
Measurement Method:	U.S. Public Health Service full-flow light extinction type smokemeter.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator, if used, removed.
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speed and Load:	Idle for 1 min, followed by full-rack acceleration to 40 mph with inertia and initially preset dynamometer load.
Procedure:	(1) Zero potentiometric recorder and 100% adjust smokemeter with engine "off" using 2 SCFM of purge air to collimating tubes. (2) Start engine and allow to idle for one min. Note maximum smoke at start on recorder. (3) After 1 min of idle, full-rack accelerate to 40 mph against full bus inertia simulation and under the initially set load of 40 hp at 30 mph in the water brake type dynamometer. Some vehicles will not reach 40 mph with 40 hp impressed at 30 mph. Operate as far past 30 mph as reasonable and discontinue. Maximum smoke normally does not occur at these higher speeds. (4) Note the maximum smoke at the start of acceleration and at upshift. (5) Repeat items (1) through (4) above two times.

TABLE 23. VEHICLE OPERATING CONDITIONS, SAMPLING PROCEDURE AND ANALYTICAL METHODS FOR DIESEL EXHAUST EMISSIONS MEASUREMENTS

Applicability: GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.

Sample Method: Exhaust obtained direct from central stack at same point odor samples are obtained, 6 ft from vehicle tailpipe exit.

Warm-up: A minimum of three runs should be conducted prior to exhaust sampling to assure the engine and system have reached operating temperature. Air conditioning "off."

Operating Conditions: The following are to be run under full inertia simulation with the air conditioning "off."

Type Operation	Vehicle Speed, mph	Vehicle Load, hp	Engine Speed, rpm	Trans Drive Range	Power Level, approx
I. Cruise	20	40	890	High	2/3 rack
II. Cruise	40	40	1590	High	2/3 rack
III. Idle	0	0	500	Neutral	Closed rack

Operating and Sampling Procedure:

(1) Operate at Condition I, 20 mph, 40 hp until CO and CO_2 instruments indicate stable engine/vehicle operation (about 1 to 1.5 min).

(2) Begin 3-min sample period for acrolein, aldehydes/formaldehyde and SO_2 at 1 liter/min observed rate. Take duplicate 5-cc syringe sample for NO_x. Record average CO and CO_2 readings during 3-min period.

(3) After 3-min sample is obtained, allow vehicle to idle and cool tires. Remove bubblers for acrolein, aldehydes/formaldehyde and SO_2. Wash down and prepare for next samples.

(4) Operate at Condition II, 40 mph, 40 hp and repeat items (2) and (3) above.

(5) Operate at Condition III, engine idle after 1-min cruise at 30 mph and 40 hp and repeat items (2) and (3) above.

(6) Repeat items (1) through (5) above three times in above sequence.

Analytical Procedure: Analysis of the diesel exhaust samples made for the chemical constituents using the procedures listed below:

Constituent	Procedure/Method	Reference
CO	Beckman 315 nondispersive infrared 0-2200 ppm CO, 5-1/4-in. sample cell	
CO_2	Beckman 315 nondispersive infrared 0-15% CO_2, 1/8-in. sample cell	
NO_x	Modified Saltzman syringe method NO plus NO_2 as ppm NO_2	PHS Publication 999-AP-11 modified
SO_2	West and Gaeke Method	PHS Publication 999-AP-11
Acrolein	4-Hexylresorcinol method	Cohen, I. R., and Altshuller, A. P., Anal. Chem., 33, 726-33 (1961) PHS Publication 999-AP-11
Total Aldehydes	3-Methyl-2 benzothiazolone hydrazone (MBTH) method	Sawicki, E., et al., Anal. Chem., 33, 93-6 (1961) Reckner, L. R., et al., Proc. API, 45, 133, 141 (1967)
Formaldehyde	Chromatropic acid method	Altshuller, A. P., et al., Anal. Chem., 33, 621-25 (1961) PHS Publication 999-AP-11 Reckner, L. R., et al., Proc. API, 45, 133, 141 (1965)

Note: Time between runs is approximately 10 to 15 min. Total sampling and ready time is 3 to 4 hr. Total analysis time is 4 hr.

TABLE 24. COMPARISON OF ODOR PANEL RESPONSES FOR ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL - INITIAL EVALUATION

Vehicle: Bus 676
Test Days: 0
Test Mileage: 0

Date: August 14 and 15, 1968
Operating Conditions*: See Tables 2 through 5

Operating Condition	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
I.	Untreated	6.3	1.9	1.8	1.0	1.1
	Treated	6.1	1.8	1.9	1.0	0.9
	Net Change	-0.2	-0.1	+0.1	0	-0.2
II.	Untreated	6.3	1.9	1.8	1.0	1.1
	Treated	6.2	1.8	1.8	1.1	1.0
	Net Change	-0.1	-0.1	0	+0.1	-0.1
III.	Untreated	5.8	1.8	1.6	0.9	1.0
	Treated	4.7	1.5	1.2	1.0	0.6
	Net Change	-1.1	-0.3	-0.4	+0.1	-0.4
IV.	Untreated	6.8	2.0	1.9	1.0	1.3
	Treated	6.2	1.9	1.8	1.1	1.1
	Net Change	-0.6	-0.1	-0.1	+0.1	-0.2
V.	Untreated	5.1	1.6	1.3	0.9	0.8
	Treated	4.6	1.3	1.2	0.9	0.7
	Net Change	-0.5	-0.3	-0.1	0	-0.1

---

*I. Constant Speed, 20 mph, 40 hp.
II. Constant Speed, 40 mph, 40 hp.
III. Idle after 30 mph, 40-hp cruise.
IV. Acceleration after 1-min idle.
V. Deceleration from 40 mph, 40-hp cruise.

TABLE 25. INITIAL VEHICLE ODOR EVALUATION SUMMARY - UNTREATED BASE FUEL

Vehicle: Bus 676
Date: August 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	I. Constant Speed	6.2	1.8	1.8	1.1	1.0
8	" "	5.9	2.0	1.8	0.9	0.9
14	" "	6.8	2.0	1.9	1.1	1.3
22	" "	6.2	1.8	1.7	0.9	1.2
		6.3	1.9	1.8	1.0	1.1
1	II. Constant Speed	5.9	1.8	1.7	0.9	0.9
7	" "	6.4	1.8	1.7	1.0	1.0
10	" "	5.9	1.8	1.8	1.0	0.9
24	" "	6.9	2.0	1.8	1.1	1.4
		6.3	1.9	1.8	1.0	1.1
4	III. Idle	6.3	1.7	1.4	1.0	1.0
11	"	5.8	1.9	1.8	0.9	1.2
18	"	5.5	1.7	1.6	0.9	1.1
23	"	5.7	1.7	1.6	0.9	0.8
		5.8	1.8	1.6	0.9	1.0
6	IV. Idle-Acceleration	6.7	1.9	1.7	1.0	1.1
13	" "	6.5	2.0	2.0	1.0	1.2
17	" "	7.1	2.2	2.0	0.9	1.6
21	" "	7.0	2.0	1.9	1.2	1.3
		6.8	2.0	1.9	1.0	1.3
5	V. Deceleration	4.8	1.4	1.2	0.9	0.7
15	"	5.3	1.7	1.4	0.9	0.9
19	"	5.0	1.6	1.3	0.8	0.9
20	"	5.1	1.6	1.2	0.9	0.7
		5.1	1.6	1.3	0.9	0.8

---

*Runs 3, 9, 12, and 16 were conducted without exhaust sample.

TABLE 25A. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: August 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	4	5	6	7	8	Avg
1	Constant Speed			3	5	2		5.9
2	Constant Speed			1	6	3		6.2
3	Blank	10						0
4	Idle			3	1	6		6.3
5	Deceleration		3	6	1			4.8
6	Idle-Acceleration				3	7		6.7
7	Constant Speed			1	4	5		6.4
8	Constant Speed			2	7	1		5.9
9	Blank	10						0
10	Constant Speed			2	7	1		5.9
11	Idle		1	1	7	1		5.8
12	Blank	10						0
13	Idle-Acceleration			2	1	7		6.5
14	Constant Speed				2	8		6.8
15	Deceleration			7	3			5.3
16	Blank	10						0
17	Idle-Acceleration				1	7	2	7.1
18	Idle			6	3	1		5.5
19	Deceleration		1	8	1			5.0
20	Deceleration			9	1			5.1
21	Idle-Acceleration				2	6	2	7.0
22	Constant Speed		1	1	3	5		6.2
23	Idle			3	7			5.7
24	Constant Speed				2	7	1	6.9

TABLE 25B. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: August 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Avg
1	Constant Speed		2	8		1.8
2	Constant Speed		2	8		1.8
3	Blank	10				0
4	Idle		3	7		1.7
5	Deceleration		6	4		1.4
6	Idle-Acceleration		1	9		1.9
7	Constant Speed		2	8		1.8
8	Constant Speed			10		2.0
9	Blank	10				0
10	Constant Speed		2	8		1.8
11	Idle		1	9		1.9
12	Blank	10				0
13	Idle-Acceleration			10		2.0
14	Constant Speed			10		2.0
15	Deceleration		3	7		1.7
16	Blank	10				0
17	Idle-Acceleration			8	2	2.2
18	Idle		3	7		1.7
19	Deceleration		4	6		1.6
20	Deceleration		4	6		1.6
21	Idle-Acceleration		1	8	1	2.0
22	Constant Speed		2	8		1.8
23	Idle		3	7		1.7
24	Constant Speed		1	8	1	2.0

TABLE 25C. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 676
Date: August 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses			
		0	1	2	Avg
1	Constant Speed		3	7	1.7
2	Constant Speed		2	8	1.8
3	Blank	10			0
4	Idle		6	4	1.4
5	Deceleration		8	2	1.2
6	Idle-Acceleration		3	7	1.7
7	Constant Speed		3	7	1.7
8	Constant Speed		2	8	1.8
9	Blank	10			0
10	Constant Speed		2	8	1.8
11	Idle		2	8	1.8
12	Blank	10			0
13	Idle-Acceleration			10	2.0
14	Constant Speed		1	9	1.9
15	Deceleration		6	4	1.4
16	Blank	10			0
17	Idle-Acceleration			10	2.0
18	Idle		4	6	1.6
19	Deceleration		7	3	1.3
20	Deceleration		8	2	1.2
21	Idle-Acceleration		1	9	1.9
22	Constant Speed		3	7	1.7
23	Idle		4	6	1.6
24	Constant Speed		2	8	1.8

TABLE 25D. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: August 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Avg
1	Constant Speed	1	9		0.9
2	Constant Speed	1	7	2	1.1
3	Blank	10			0
4	Idle	1	8	1	1.0
5	Deceleration	1	9		0.9
6	Idle-Acceleration	2	6	2	1.0
7	Constant Speed		10		1.0
8	Constant Speed	1	9		0.9
9	Blank	10			0
10	Constant Speed		10		1.0
11	Idle	2	7	1	0.9
12	Blank	10			0
13	Idle-Acceleration	1	8	1	1.0
14	Constant Speed	1	7	2	1.1
15	Deceleration	2	7	1	0.9
16	Blank	10			0
17	Idle-Acceleration	1	9		0.9
18	Idle	1	9		0.9
19	Deceleration	2	8		0.8
20	Deceleration	1	9		0.9
21	Idle-Acceleration		8	2	1.2
22	Constant Speed	1	9		0.9
23	Idle	1	9		0.9
24	Constant Speed	1	7	2	1.1

TABLE 25E. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: August 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Avg
1	Constant Speed	1	9		0.9
2	Constant Speed	1	8	1	1.0
3	Blank	10			0
4	Idle	1	8	1	1.0
5	Deceleration	3	7		0.7
6	Idle-Acceleration		9	1	1.1
7	Constant Speed	1	8	1	1.0
8	Constant Speed	1	9		0.9
9	Blank	10			0
10	Constant Speed	2	7	1	0.9
11	Idle		8	2	1.2
12	Blank	10			0
13	Idle-Acceleration		8	2	1.2
14	Constant Speed	1	5	4	1.3
15	Deceleration	1	9		0.9
16	Blank	10			0
17	Idle-Acceleration	1	2	7	1.6
18	Idle	1	7	2	1.1
19	Deceleration	1	9		0.9
20	Deceleration	3	7		0.7
21	Idle-Acceleration	1	5	4	1.3
22	Constant Speed		8	2	1.2
23	Idle	2	8		0.3
24	Constant Speed	1	4	5	1.4

TABLE 26. INITIAL VEHICLE ODOR EVALUATION SUMMARY - ADDITIVE TREATED FUEL

Vehicle: Bus 676
Date: August 14, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
8	I. Constant Speed	6.7	1.9	1.9	1.0	0.8
11	" "	5.7	1.8	1.6	0.9	1.0
20	" "	5.9	1.8	1.7	1.0	0.9
24	" "	5.9	1.8	1.4	1.2	0.9
		6.1	1.8	1.9	1.0	0.9
1	II. Constant Speed	5.6	1.6	1.3	1.0	0.6
5	" "	6.3	1.9	1.6	1.3	1.1
17	" "	6.7	2.0	1.8	1.0	1.1
21	" "	6.0	1.7	1.7	1.0	1.1
		6.2	1.8	1.8	1.1	1.0
3	III. Idle	4.4	1.4	1.2	0.8	0.3
6	"	4.8	1.4	1.1	1.3	0.7
14	"	4.8	1.6	1.3	0.9	0.6
16	"	4.8	1.4	1.2	1.1	0.7
		4.7	1.5	1.2	1.0	0.6
2	IV. Idle-Acceleration	6.7	2.0	1.8	1.1	1.0
9	" "	6.4	2.0	1.9	0.9	1.1
19	" "	5.9	1.9	1.9	1.2	1.1
22	" "	5.9	1.8	1.4	1.3	1.0
		6.2	1.9	1.8	1.1	1.1
4	V. Deceleration	4.2	1.2	1.0	0.8	0.7
10	"	5.0	1.6	1.4	0.8	0.8
13	"	4.3	1.2	1.2	0.9	0.4
23	"	4.7	1.3	1.1	0.9	0.7
		4.6	1.3	1.2	0.9	0.7

---

*Runs 7, 12, 15, and 18 were conducted without exhaust sample.

TABLE 26A. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Standard)

Vehicle: Bus 676
Date: August 14, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	3	4	5	6	7	Avg
1	Constant Speed				4	6		5.6
2	Idle-Acceleration					3	7	6.7
3	Idle			6	4			4.4
4	Deceleration			9		1		4.2
5	Constant Speed				1	5	4	6.3
6	Idle			5	2	3		4.8
7	Blank	10						0
8	Constant Speed				2	6	3	6.7
9	Idle-Acceleration					6	4	6.4
10	Deceleration			2	6	2		5.0
11	Constant Speed				3	6	1	5.7
12	Blank	10						0
13	Deceleration			7	3			4.3
14	Idle			5	2	3		4.8
15	Blank	10						0
16	Idle		1	2	5	2		4.8
17	Constant Speed					3	7	6.7
18	Blank	10						0
19	Idle-Acceleration				1	3	6	5.9
20	Constant Speed				2	7	1	5.9
21	Constant Speed			1	3	1	5	6.0
22	Idle-Acceleration				5	1	4	5.9
23	Deceleration			5	3	2		4.7
24	Constant Speed			1	1	6	2	5.9
25	Deceleration		1	4	5			4.4

TABLE 26B. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: August 14, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Avg
1	Constant Speed		4	6		1.6
2	Idle-Acceleration			10		2.0
3	Idle		7	2	1	1.4
4	Deceleration		8	2		1.2
5	Constant Speed		1	9		1.9
6	Idle		6	4		1.4
7	Blank	10				0
8	Constant Speed		1	9		1.9
9	Idle-Acceleration			10		2.0
10	Deceleration		4	6		1.6
11	Constant Speed		2	8		1.8
12	Blank	10				0
13	Deceleration		8	2		1.2
14	Idle		4	6		1.6
15	Blank	10				0
16	Idle		6	4		1.4
17	Constant Speed			10		2.0
18	Blank	10				0
19	Idle-Acceleration		1	9		1.9
20	Constant Speed		2	8		1.8
21	Constant Speed		3	7		1.7
22	Idle-Acceleration		2	8		1.8
23	Deceleration		7	3		1.3
24	Constant Speed		2	8		1.8
25	Deceleration		8	2		1.2

TABLE 26C. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 676
Date: August 14, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"O" Oily Responses			
		0	1	2	Avg
1	Constant Speed		7	3	1.3
2	Idle-Acceleration		2	8	1.8
3	Idle		8	2	1.2
4	Deceleration	1	8	1	1.0
5	Constant Speed		4	6	1.6
6	Idle		9	1	1.1
7	Blank	10			0
8	Constant Speed		1	9	1.9
9	Idle-Acceleration		1	9	1.9
10	Deceleration		6	4	1.4
11	Constant Speed		4	6	1.6
12	Blank	10			0
13	Deceleration		8	2	1.2
14	Idle		7	3	1.3
15	Blank	10			0
16	Idle		8	2	1.2
17	Constant Speed		2	8	1.8
18	Blank	10			0
19	Idle-Acceleration		1	9	1.9
20	Constant Speed		3	7	1.7
21	Constant Speed		3	7	1.7
22	Idle-Acceleration		6	4	1.4
23	Deceleration		9	1	1.1
24	Constant Speed		6	4	1.4
25	Deceleration		9	1	1.1

TABLE 26D. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: August 14, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Avg
1	Constant Speed	2	6	2	1.0
2	Idle-Acceleration		9	1	1.1
3	Idle	3	6	1	0.8
4	Deceleration	3	6	1	0.8
5	Constant Speed		7	3	1.3
6	Idle		7	3	1.3
7	Blank	10			0
8	Constant Speed	1	8	1	1.0
9	Idle-Acceleration	2	7	1	0.9
10	Deceleration	2	8		0.8
11	Constant Speed	2	7	1	0.9
12	Blank	10			0
13	Deceleration	1	9		0.9
14	Idle	1	9		0.9
15	Blank	10			0
16	Idle	1	7	2	1.1
17	Constant Speed	2	6	2	1.0
18	Blank	10			0
19	Idle-Acceleration	1	6	3	1.2
20	Constant Speed	1	8	1	1.0
21	Constant Speed	1	8	1	1.0
22	Idle-Acceleration	1	5	4	1.3
23	Deceleration	1	9		0.9
24	Constant Speed		8	2	1.2
25	Deceleration	2	8		0.8

TABLE 26E. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: August 14, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	Constant Speed	4	6		0.6
2	Idle-Acceleration		10		1.0
3	Idle	7	3		0.3
4	Deceleration	3	7		0.7
5	Constant Speed		9	1	1.1
6	Idle	3	7		0.7
7	Blank	10			0
8	Constant Speed	2	8		0.8
9	Idle-Acceleration		9	1	1.1
10	Deceleration	2	8		0.8
11	Constant Speed		10		1.0
12	Blank	10			0
13	Deceleration	6	4		0.4
14	Idle	4	6		0.6
15	Blank	10			0
16	Idle	3	7		0.7
17	Constant Speed		9	1	1.1
18	Blank	10			0
19	Idle-Acceleration	1	7	2	1.1
20	Constant Speed	1	9		0.9
21	Constant Speed		9	1	1.1
22	Idle-Acceleration	1	8	1	1.0
23	Deceleration	3	7		0.7
24	Constant Speed	2	7	1	0.9
25	Deceleration	6	4		0.4

TABLE 27. COMPUTATION OF "U" STATISTICS TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 676
Test Days: 0
Test Mileage: 0

Date: August 14 and 15, 1968
Operating Conditions: See Tables 2 through 5
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Relative Ranking	Odor Quality "D"	Odor Quality "B"	Odor Quality "O"	Odor Quality "A"	Odor Quality "P"
I 20 mph 40 hp	1	A	$A^{(4)}$	A	$S^{(4)}$	A
	2	$A^{(4)}$	$S^{(4)}$	A	$A^{(4)}$	$A^{(4)}$
	3	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	4	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$	A	$A^{(4)}$
	5	$S^{(1)}$	$A^{(4)}$	S	A	$S^{(4)}$
	6	S	A	S	S	$A^{(4)}$
	7	$A^{(2)}$	S	$A^{(4)}$	S	S
	8	S	S	$S^{(4)}$	A	S
	$U_s^{(3)}$	4	5	4	7	2.5
II 40 mph 40 hp	1	A	A	A	S	A
	2	S	A	A	$A^{(4)}$	S
	3	S	S	$S^{(4)}$	$S^{(4)}$	S
	4	A	S	$A^{(4)}$	$A^{(4)}$	S
	5	A	S	$S^{(4)}$	$S^{(4)}$	A
	6	S	A	$S^{(4)}$	$A^{(4)}$	A
	7	A	$S^{(4)}$	$A^{(4)}$	S	A
	8	S	$A^{(4)}$	$S^{(4)}$	A	S
	U_s	7	6.5	6	6	7
III Idle	1	A	A	A	A	A
	2	A	A	A	$S^{(4)}$	A
	3	A	A	A	$A^{(4)}$	A
	4	A	A	A	$S^{(4)}$	A
	5	S	S	S	$S^{(4)}$	S
	6	S	S	S	S	S
	7	S	S	S	A	S
	8	S	S	S	A	S
	U_s	0	0	0	5.5	0
IV Idle- Acceleration	1	A	A	A	$S^{(4)}$	A
	2	A	$S^{(4)}$	S	$A^{(4)}$	A
	3	A	$A^{(4)}$	A	S	$A^{(4)}$
	4	S	$A^{(4)}$	$A^{(4)}$	S	$S^{(4)}$
	5	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$	A	$A^{(4)}$
	6	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	S
	7	S	$S^{(4)}$	S	$A^{(4)}$	S
	8	S	S	S	A	S
	U_s	1.5	4.5	4	5	1
V Deceleration	1	A	A	A	$A^{(4)}$	A
	2	A	A	A	$S^{(4)}$	S
	3	A	A	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$
	4	S	S	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$
	5	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$
	6	$S^{(4)}$	$A^{(4)}$	S	$S^{(4)}$	A
	7	S	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$	S
	8	S	S	$S^{(4)}$	$S^{(4)}$	S
	U_s	1.5	4	4.5	6	4

(1) "S" stands for EM-70-F (No. 1 Diesel) untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 28. INITIAL COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 676
Test Days: 0
Test Mileage: 0

Date: August 14 and 15, 1968
Operating Conditions: See Tables 21 and 22
Base Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity Max	Min	Avg
A. Untreated	20	49	15	12	13.3
Treated	20	50	13	12	12.3
Net Change					-1.0
B. Untreated	25	61	10	9	9.7
Treated	25	62	10	9	9.3
Net Change					-0.4
C. Untreated	30	72	9	9	9.0
Treated	30	71	10	8	9.0
Net Change					0
D. Untreated	35	82	8	7	7.7
Treated	35	81	8	7	7.7
Net Change					0

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity Max	Min	Avg
Start of engine			
Untreated	14	13	13.7
Treated	15	14	14.7
Net Change			+1.0
During acceleration			
Untreated	10	8	8.7
Treated	9	6	7.3
Net Change			-1.4
After upshift			
Untreated	8	8	8.0
Treated	9	8	8.7
Net Change			+0.7

TABLE 29. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 676
Date: August 13 and 16, 1968

Operating Conditions: See Table 23
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Run No.	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic* Aldehyde, ppm		Formaldehyde, ppm		NO_2, ppm		SO_2, ppm		Adjusting Factor	
		Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	1	900	900	5.00	4.30	1900	2220	2.96	4.65	32.04	31.75	18.38	18.13	970.20	935.50	0.042	0.055		
20 mph	5	825	875	5.00	4.30	1920	2030	3.00	2.52	33.01	34.96	20.85	19.85	947.10	912.45	0.070	0.070		
40 hp	9	780	650	4.80	4.10	1490		3.00	3.03	32.70	30.38	18.80	21.58	958.65	900.90	0.042	0.041		
	13	550	675	4.70	4.10	1695		2.71	3.70	28.86	31.35	18.13	18.75	947.10	912.45	0.039	0.027		
As-measured average		765	775	4.88	4.20	1751	2125	2.92	3.48	31.65	32.11	18.97	19.58	955.76	915.33	0.048	0.048		
Adjusted average†		2315	2720	14.80	14.70	5300	7450	8.85	12.20	96.0	112.50	57.40	68.7	2890	3210	0.145	0.168	3.03	3.51
II	2	225	200	4.10	3.70	1810	1980	2.13	2.14	25.25	23.30	13.23	14.97	681.45	727.65	0.070	0.028		
30 mph	6	225	170	4.10	3.60	1835	1850	2.13	2.40	29.40	26.46	14.14	11.76	669.90	727.65	0.070	0.029		
40 hp	10	225	200	4.70	3.55	1500		2.27	2.17	30.09	25.77	14.46	15.04	727.65	727.65	0.041	0.027		
	14	225	170	4.10	3.50	1650		2.38	2.20	28.16	24.70	13.23	12.98	658.35	727.65	0.073	0.027		
As-measured average		225	185	4.25	3.59	1699	1915	2.23	2.23	28.23	25.06	13.77	13.69	684.35	727.65	0.064	0.028		
Adjusted average		790	770	14.90	14.90	5960	7950	7.73	9.25	982.0	104.1	48.3	56.4	2400	3020	0.224	0.116	3.51	4.15
III	3	210	170	4.00	4.00	1835	2000	1.50	1.40	20.39	21.36	9.56	11.03	669.90	681.45	0.028	0.028		
40 mph	7	225	150	3.70	3.60	1790	1625	1.75	1.28	22.54	22.54	10.42	11.16	646.80	669.90	0.028	0.044		
40 hp	11	200	150	4.00	3.60	1570		1.65	1.54	23.32	25.77	13.12	12.03	646.80	635.25	0.071	0.027		
	15	200	150	3.70	3.50	1670		1.74	1.68	23.30	24.05	11.76	11.76	658.35	646.80	0.022	0.055		
As-measured average		209	155	3.85	3.68	1716	1813	1.66	1.48	22.39	23.43	11.22	11.46	655.46	658.35	0.037	0.039		
Adjusted average		810	615	14.90	14.55	6650	7180	6.44	5.85	86.8	92.80	43.5	34.3	2545	6020	0.143	0.154	3.88	3.96
IV	4	225	170	1.35	1.10	700	640	2.13	1.78	22.33	33.01	13.23	16.91	311.85	265.65	0.070	0.042		
Idle	8	275	170	1.10	1.10	685	610	2.25	1.90	23.52	23.52	13.39	13.39	300.30	265.65	0.126	0.042		
	12	200	150	1.35	1.00	615		1.89	2.05	22.31	22.79	13.90	13.54	277.20	277.20	0.143	0.083		
	16	200	170	1.35	1.10	635		2.38	1.94	20.39	20.20	18.38	10.88	288.75	242.55	0.158	0.083		
As-measured average		225	165	1.29	1.08	659	625	2.16	1.92	22.14	24.88	14.73	13.68	294.53	262.76	0.124	0.063		
Adjusted average		2570	2245	14.75	14.70	7530	8510	6.46	26.15	254.5	339.0	168.1	186.0	3365	3580	1.42	0.857	11.40	13.60

---

*Total as ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 30. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 676
Test Days: 0
Test Mileage: 0

Date: August 13 and 16, 1968
Operating Conditions: See Table 23
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formaldehyde	NO_x	SO_2
I 20 mph 40 hp	1	S(1)	A	-	A	S	S(4)	A	A
	2	A(2)	A	-	S	A	A(4)	A	S
	3	A	A	-	S	A	S	A	A
	4	S	A	-	S	A	A	A	S
	5	S	S	-	S	S	S	S	S
	6	A	S	-	A	S	A	S	A
	7	A	S	-	A	S	S	S	S(4)
	8	S	S	-	A	A	A	S	A(4)
	U_s(3)	8	0	-	4	7	6.5	0	7.5
II 30 mph 40 hp	1	A	A	-	S	S	A	S	A
	2	A	A	-	S	S	A	S	A
	3	A	A	-	A	A	S	S	A
	4	A	A	-	A	A	S	S(4)	A
	5	S	S	-	A	A	S	A(4)	S
	6	S	S	-	S	S	S	A(4)	S
	7	S	S	-	S	S	A	A(4)	S
	8	S	S	-	A	A	A	A(4)	S
	U_s	0	0	-	7	6	8	2	0
III 40 mph 40 hp	1	A	A	-	A	S	S	A	S
	2	A	A	-	A	A	S	S(4)	A
	3	A	A	-	S	S(4)	A	A(4)	S(4)
	4	A	S	-	A	A(4)	A	S(4)	A(4)
	5	S	S	-	S	S	A	S	S(4)
	6	S	A(4)	-	A	S	S	A(4)	A
	7	S	S(4)	-	S	A	A	S(4)	A
	8	S	S(4)	-	S	A	S	A	S
	U_s	0	3	-	3	6.5	7	7.5	7
IV Idle 0 hp	1	A	A	-	A	A	A	A	A
	2	A	A(4)	-	S	S	S	A	A
	3	A	A(4)	-	A	S	A(4)	A	S
	4	A	S(4)	-	A	S	S(4)	A(4)	A
	5	S	A(4)	-	A	A	A	S(4)	A
	6	S	S	-	S	S(4)	S	S	S
	7	S	S	-	S	A(4)	A	S	S
	8	S	S	-	S	A	S	S	S
	U_s	0	1.5	-	3	5.5	6.5	0.5	2

(1) "S" stands for EM-70-F untreated fuel.

(2) "A" stands for EM-70-F treated with odor additive.

(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.

(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 31. COMPARISON OF ODOR PANEL RESPONSES FOR ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL - INITIAL EVALUATION

Vehicle: Bus 678
Test Days: 0
Test Mileage: 0

Date: August 20 and 21, 1968
Operating Conditions*: See Tables 2 through 5

Operating Condition	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
I.	Untreated	6.6	2.0	1.9	1.1	1.5
	Treated	6.3	2.0	1.8	1.2	1.2
	Net Change	-0.3	0	-0.1	+0.1	-0.3
II.	Untreated	5.8	1.9	1.8	1.0	1.2
	Treated	6.4	2.0	1.9	1.4	1.2
	Net Change	+0.6	+0.1	+0.1	+0.4	0
III.	Untreated	5.8	1.8	1.7	1.0	1.0
	Treated	5.6	2.0	1.6	1.2	1.0
	Net Change	-0.2	+0.2	-0.1	+0.2	0
IV.	Untreated	6.2	1.9	1.9	1.1	1.3
	Treated	6.4	2.0	1.9	1.1	1.2
	Net Change	+0.2	+0.1	0	0	-0.1
V.	Untreated	5.4	1.8	1.8	1.0	0.9
	Treated	5.1	1.8	1.4	1.0	0.9
	Net Change	-0.3	0	-0.4	0	0

---

*I. Constant Speed, 20 mph, 40 hp.
II. Constant Speed, 40 mph, 40 hp.
III. Idle after 30 mph, 40-hp cruise.
IV. Acceleration after 1-min idle.
V. Deceleration from 40 mph, 40-hp cruise.

TABLE 32. INITIAL VEHICLE ODOR EVALUATION SUMMARY - UNTREATED BASE FUEL

Vehicle: Bus 678
Date: August 21, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
5	I. Constant Speed	6.7	1.8	1.7	1.0	1.9
8	" "	5.9	1.9	1.8	1.2	1.2
18	" "	7.0	2.1	1.9	1.3	1.5
20	" "	6.7	2.0	2.0	1.0	1.5
		6.6	2.0	1.9	1.1	1.5
1	II. Constant Speed	5.9	1.8	1.8	1.0	1.2
3	" "	5.0	1.7	1.7	0.8	1.1
10	" "	6.3	1.9	1.8	1.0	1.2
23	" "	6.1	2.0	1.9	1.1	1.2
		5.8	1.9	1.8	1.0	1.2
2	III. Idle	5.0	1.7	1.5	0.9	0.9
11	"	6.0	1.9	1.8	1.2	0.9
17	"	6.0	1.8	1.8	1.0	1.1
24	"	6.0	1.9	1.8	0.9	1.2
		5.8	1.8	1.7	1.0	1.0
6	IV. Idle-Acceleration	6.0	2.0	1.9	1.1	1.2
14	" "	6.5	1.8	1.8	1.1	1.2
16	" "	6.7	2.1	1.9	1.2	1.5
22	" "	5.6	1.8	1.8	1.0	1.3
		6.2	1.9	1.9	1.1	1.3
7	V. Deceleration	5.0	1.7	1.7	0.8	0.9
13	"	5.2	1.8	1.8	0.9	0.9
15	"	5.8	1.8	1.8	1.1	0.8
21	"	5.7	1.8	1.8	1.0	0.8
		5.4	1.8	1.8	1.0	0.9

---

*Runs 4, 9, 12, and 19 were conducted without exhaust sample.

TABLE 32A. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Standard)

Vehicle: Bus 678
Date: August 21, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	4	5	6	7	8	Avg
1	Constant Speed			2	7	1		5.9
2	Idle			10				5.0
3	Constant Speed		5		5			5.0
4	Blank	10						0
5	Constant Speed				3	7		6.7
6	Idle-Acceleration			2	6	2		6.0
7	Deceleration		4	2	4			5.0
8	Constant Speed			2	7	1		5.9
9	Blank	10						0
10	Constant Speed			3	1	6		6.3
11	Idle		1	1	7	1		6.0
12	Blank	10						0
13	Deceleration		1	6	3			5.2
14	Idle-Acceleration			4	1	1	4	6.5
15	Deceleration			4	4	2		5.8
16	Idle-Acceleration				3	7		6.7
17	Idle			4	2	4		6.0
18	Constant Speed					10		7.0
19	Blank	10						0
20	Constant Speed				3	7		6.7
21	Deceleration		1	1	8			5.7
22	Idle-Acceleration			2	4	4		5.6
23	Constant Speed				9	1		6.1
24	Idle				10			6.0

TABLE 32B. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: August 21, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Avg
1	Constant Speed		2	8		1.8
2	Idle		3	7		1.7
3	Constant Speed		3	7		1.7
4	Blank	10				0
5	Constant Speed		2	8		1.8
6	Idle-Acceleration		1	8	1	2.0
7	Deceleration		3	7		1.7
8	Constant Speed		1	9		1.9
9	Blank	10				0
10	Constant Speed		2	7	1	1.9
11	Idle		1	9		1.9
12	Blank	10				0
13	Deceleration		2	8		1.8
14	Idle-Acceleration		4	4	2	1.8
15	Deceleration		2	8		1.8
16	Idle-Acceleration			9	1	2.1
17	Idle		2	8		1.8
18	Constant Speed			9	1	2.1
19	Blank	10				0
20	Constant Speed			10		2.0
21	Deceleration		2	8		1.8
22	Idle-Acceleration		2	8		1.8
23	Constant Speed			10		2.0
24	Idle		1	9		1.9

TABLE 32C. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 678
Date: August 21, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Avg
1	Constant Speed		2	8		1.8
2	Idle		5	5		1.5
3	Constant Speed		3	7		1.7
4	Blank	10				0
5	Constant Speed		3	7		1.7
6	Idle-Acceleration		1	9		1.9
7	Deceleration		3	7		1.7
8	Constant Speed		2	8		1.8
9	Blank	10				0
10	Constant Speed		2	8		1.8
11	Idle		2	8		1.8
12	Blank	10				0
13	Deceleration		2	8		1.8
14	Idle-Acceleration		3	6	1	1.8
15	Deceleration		2	8		1.8
16	Idle-Acceleration		1	9		1.9
17	Idle		2	8		1.8
18	Constant Speed		1	9		1.9
19	Blank	10				0
20	Constant Speed			10		2.0
21	Deceleration		2	8		1.8
22	Idle-Acceleration		2	8		1.8
23	Constant Speed		1	9		1.9
24	Idle		2	8		1.8

TABLE 32D. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 678
Date: August 21, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Response 0	1	2	Avg
1	Constant Speed	1	8	1	1.0
2	Idle	1	9		0.9
3	Constant Speed	2	8		0.8
4	Blank	10			0
5	Constant Speed	1	8	1	1.0
6	Idle-Acceleration		9	1	1.1
7	Deceleration	3	6	1	0.8
8	Constant Speed	1	6	3	1.2
9	Blank	10			0
10	Constant Speed		10		1.0
11	Idle	1	6	3	1.2
12	Blank	10			0
13	Deceleration	2	7	1	0.9
14	Idle-Acceleration		9	1	1.1
15	Deceleration		9	1	1.1
16	Idle-Acceleration	1	6	3	1.2
17	Idle		10		1.0
18	Constant Speed		7	3	1.3
19	Blank	10			0
20	Constant Speed	1	8	1	1.0
21	Deceleration	1	8	1	1.0
22	Idle-Acceleration	1	8	1	1.0
23	Constant Speed	1	7	2	1.1
24	Idle	1	9		0.9

TABLE 32E. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 678
Date: August 21, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	Constant Speed		8	2	1.2
2	Idle	2	7	1	0.9
3	Constant Speed	1	7	2	1.1
4	Blank	10			0
5	Constant Speed		1	9	1.9
6	Idle-Acceleration		8	2	1.2
7	Deceleration	2	7	1	0.9
8	Constant Speed		8	2	1.2
9	Blank	10			0
10	Constant Speed	1	6	3	1.2
11	Idle	2	7	1	0.9
12	Blank	10			0
13	Deceleration	2	7	1	0.9
14	Idle-Acceleration	1	6	3	1.2
15	Deceleration	4	4	2	0.8
16	Idle-Acceleration	1	3	6	1.5
17	Idle	1	7	2	1.1
18	Constant Speed		5	5	1.5
19	Blank	10			0
20	Constant Speed		5	5	1.5
21	Deceleration	3	6	1	0.8
22	Idle-Acceleration		7	3	1.3
23	Constant Speed	1	6	3	1.2
24	Idle	1	6	3	1.2

TABLE 33. INITIAL VEHICLE ODOR EVALUATION SUMMARY - ADDITIVE TREATED FUEL

Vehicle: Bus 678
Date: August 20, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
6	I. Constant Speed	6.8	2.1	1.9	1.2	1.7
8	" "	5.9	2.0	1.8	1.0	1.1
12	" "	6.0	2.0	1.7	1.1	0.9
20	" "	6.6	2.0	1.8	1.3	1.1
		6.3	2.0	1.8	1.2	1.2
2	II. Constant Speed	6.0	2.0	1.9	1.0	1.1
17	" "	6.9	2.1	1.9	1.6	1.1
19	" "	6.2	1.9	1.8	1.1	1.2
23	" "	6.3	2.0	1.9	1.7	1.2
		6.4	2.0	1.9	1.4	1.2
5	III. Idle	5.0	1.9	1.7	0.9	1.0
13	"	5.3	1.8	1.3	1.0	0.9
18	"	6.2	2.1	1.7	1.5	1.1
22	"	6.0	2.0	1.8	1.2	1.1
		5.6	2.0	1.6	1.2	1.0
4	IV. Idle-Acceleration	6.5	2.1	1.9	1.1	1.1
10	" "	6.0	1.9	1.9	1.1	1.3
15	" "	6.6	2.0	1.8	1.1	1.2
24	" "	6.5	1.9	1.8	1.2	1.0
		6.4	2.0	1.9	1.1	1.2
1	V. Deceleration	5.3	1.9	1.7	0.9	1.0
9	"	5.1	1.7	1.2	1.0	0.9
16	"	5.0	1.7	1.3	1.0	0.9
21	"	5.1	1.8	1.2	1.1	0.7
		5.1	1.8	1.4	1.0	0.9

---

*Runs 3, 7, 11, and 14 were conducted without exhaust sample.

TABLE 33A. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Standard)

Vehicle: Bus 678
Date: August 20, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"D" Diesel Composite Responses 0	4	5	6	7	Avg
1	Deceleration			7	3		5.3
2	Constant Speed			1	8	1	6.0
3	Blank	10					0
4	Idle-Acceleration				5	5	6.5
5	Idle		2	6	2		5.0
6	Constant Speed				2	8	6.8
7	Blank	10					0
8	Constant Speed			2	7	1	5.9
9	Deceleration			9	1		5.1
10	Idle-Acceleration			1	8	1	6.0
11	Blank	10					0
12	Constant Speed			1	8	1	6.0
13	Idle			7	3		5.3
14	Blank	10					0
15	Idle-Acceleration				4	6	6.6
16	Deceleration			10			5.0
17	Constant Speed				1	9	6.9
18	Idle			1	6	3	6.2
19	Constant Speed			1	6	3	6.2
20	Constant Speed				4	6	6.6
21	Deceleration			9	1		5.1
22	Idle			2	6	2	6.0
23	Constant Speed				7	3	6.3
24	Idle-Acceleration			1	3	6	6.5

TABLE 33B. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: August 20, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Avg
1	Deceleration		1	9		1.9
2	Constant Speed			10		2.0
3	Blank	10				0
4	Idle-Acceleration			9	1	2.1
5	Idle		1	9		1.9
6	Constant Speed			9	1	2.1
7	Blank	10				0
8	Constant Speed			10		2.0
9	Deceleration		3	7		1.7
10	Idle-Acceleration		1	9		1.9
11	Blank	10				0
12	Constant Speed			10		2.0
13	Idle		2	8		1.8
14	Blank	10				0
15	Idle-Acceleration		1	8	1	2.0
16	Deceleration		3	7		1.7
17	Constant Speed			9	1	2.1
18	Idle			9	1	2.1
19	Constant Speed		1	9		1.9
20	Constant Speed			10		2.0
21	Deceleration		2	8		1.8
22	Idle		1	8	1	2.0
23	Constant Speed			10		2.0
24	Idle-Acceleration		1	9		1.9

TABLE 33C. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 678
Date: August 20, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Avg
1	Deceleration		3	7	1.7
2	Constant Speed		1	9	1.9
3	Blank	10			0
4	Idle-Acceleration		1	9	1.9
5	Idle		3	7	1.7
6	Constant Speed		1	9	1.9
7	Blank	10			0
8	Constant Speed		2	8	1.8
9	Deceleration		8	2	1.2
10	Idle-Acceleration		1	9	1.9
11	Blank	10			0
12	Constant Speed		3	7	1.7
13	Idle		7	3	1.3
14	Blank	10			0
15	Idle-Acceleration		2	8	1.8
16	Deceleration		7	3	1.3
17	Constant Speed		1	9	1.9
18	Idle		3	7	1.7
19	Constant Speed		2	8	1.8
20	Constant Speed		2	8	1.8
21	Deceleration		8	2	1.2
22	Idle		2	8	1.8
23	Constant Speed		1	9	1.9
24	Idle-Acceleration		2	8	1.8

TABLE 33D. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 678
Date: August 20, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Avg
1	Deceleration	1	9		0.9
2	Constant Speed	1	8	1	1.0
3	Blank	10			0
4	Idle-Acceleration		9	1	1.1
5	Idle	1	9		0.9
6	Constant Speed		8	2	1.2
7	Blank	10			0
8	Constant Speed	1	8	1	1.0
9	Deceleration		10		1.0
10	Idle-Acceleration	1	7	2	1.1
11	Blank	10			0
12	Constant Speed		9	1	1.1
13	Idle		10		1.0
14	Blank	10			0
15	Idle-Acceleration	1	7	2	1.1
16	Deceleration	1	8	1	1.0
17	Constant Speed		4	6	1.6
18	Idle	1	3	6	1.5
19	Constant Speed		9	1	1.1
20	Constant Speed		7	3	1.3
21	Deceleration		9	1	1.1
22	Idle		8	2	1.2
23	Constant Speed		3	7	1.7
24	Idle-Acceleration		8	2	1.2

TABLE 33E. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 678
Date: August 20, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	Deceleration	1	8	1	1.0
2	Constant Speed		9	1	1.1
3	Blank	10			0
4	Idle-Acceleration		9	1	1.1
5	Idle	1	8	1	1.0
6	Constant Speed		3	7	1.7
7	Blank	10			0
8	Constant Speed		9	1	1.1
9	Deceleration	1	9		0.9
10	Idle-Acceleration		7	3	1.3
11	Blank	10			0
12	Constant Speed	1	9		0.9
13	Idle	1	9		0.9
14	Blank	10			0
15	Idle-Acceleration	2	4	4	1.2
16	Deceleration	1	9		0.9
17	Constant Speed		9	1	1.1
18	Idle	1	7	2	1.1
19	Constant Speed		8	2	1.2
20	Constant Speed		9	1	1.1
21	Deceleration	3	7		0.7
22	Idle		9	1	1.1
23	Constant Speed	1	6	3	1.2
24	Idle-Acceleration	1	8	1	1.0

TABLE 34 COMPUTATION OF "U" STATISTICS TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 678
Test Days: 0
Test Mileage: 0

Date: August 20 and 21, 1968
Operating Conditions: See Tables 2 through 5
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
I	1	$S^{(4)}$	S	$A^{(4)}$	$S^{(4)}$	A
20 mph	2	$A^{(4)}$	S	$S^{(4)}$	$A^{(4)}$	A
40 hp	3	A	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	A
	4	A	$S^{(4)}$	$S^{(4)}$	A	S
	5	$S^{(1)}$	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	S
	6	S	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$	S
	7	$A^{(2)}$	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$	A
	8	S	$A^{(4)}$	S	$A^{(4)}$	S
	$U_s^{(3)}$	5.5	5	6	7	3
II	1	S	S	S	S	$A^{(4)}$
40 mph	2	S	S	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
40 hp	3	A	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$
	4	S	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	5	A	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$
	6	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	7	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	A	$A^{(4)}$
	8	A	A	$A^{(4)}$	A	$S^{(4)}$
	U_s	3.5	2.5	3.5	2.5	4.5
III	1	$S^{(4)}$	S	A	$S^{(4)}$	$S^{(4)}$
Idle	2	$A^{(4)}$	$A^{(4)}$	S	$A^{(4)}$	$A^{(4)}$
	3	A	$S^{(4)}$	A	$S^{(4)}$	$S^{(4)}$
	4	$S^{(4)}$	$S^{(4)}$	A	$A^{(4)}$	A
	5	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$	$A^{(4)}$
	6	$S^{(4)}$	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$
	7	$S^{(4)}$	A	$S^{(4)}$	$S^{(4)}$	$A^{(4)}$
	8	A	A	$S^{(4)}$	A	S
	U_s	8	3.5	4.5	5	8

Operating Condition	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
IV	1	S	S	$S^{(4)}$	S	A
Idle-	2	$A^{(4)}$	S	$A^{(4)}$	$A^{(4)}$	A
Acceleration	3	$S^{(4)}$	A	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	4	$A^{(4)}$	A	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$
	5	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	6	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$
	7	A	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	8	S	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	S
	U_s	6.5	6	8	6.5	3.5
V	1	$S^{(4)}$	$A^{(4)}$	A	S	A
Deceleration	2	$A^{(4)}$	$S^{(4)}$	A	$A^{(4)}$	S
	3	A	$A^{(4)}$	A	$S^{(4)}$	S
	4	A	$S^{(4)}$	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$
	5	S	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$
	6	A	$S^{(4)}$	S	$A^{(4)}$	$A^{(4)}$
	7	S	$S^{(4)}$	S	$S^{(4)}$	$S^{(4)}$
	8	S	A	S	$A^{(4)}$	A
	U_s	4.5	5.5	0.5	6	6

(1) "S" stands for EM-70-F (No. 1 Diesel) untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for 8 relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 35. INITIAL COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 678
Test Days: 0
Test Mileage: 0

Date: August 20 and 21, 1968
Operating Conditions: See Tables 21 and 22

Constant Speed Results (all open-rack--maximum output)

Type Operation		Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
				Max	Min	Avg
A.	Untreated	20	40	18	18	18.0
	Treated	20	40	21	18	19.6
	Net Change					+1.6
B.	Untreated	25	51	11	11	11.0
	Treated	25	51	14	12	13.3
	Net Change					+2.3
C.	Untreated	30	61	10	9	9.7
	Treated	30	61	13	11	12.3
	Net Change					+2.6
D.	Untreated	35	70	8	8	8.0
	Treated	35	70	11	10	10.7
	Net Change					+2.7

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of engine			
Untreated	10	9	9.7
Treated	11	8	9.3
Net Change			-0.4
During acceleration			
Untreated	9	8	8.3
Treated	10	8	8.7
Net Change			+0.4
After upshift			
Untreated	10	9	9.3
Treated	11	10	10.3
Net Change			+1.0

TABLE 36 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 678
Date: August 19 and 22, 1968

Operating Conditions: See Table 23
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Run No.	CO, ppm		CO_2, %		HHC, ppm		Acrolein, ppm		Aliphatic* Aldehyde, ppm		Formaldehyde, ppm		NO_x, ppm		SO_2, ppm		Adjusting Factor	
		Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	1	1500	1600	5.40	4.80		1400	5.50	7.41	41.75	42.14	17.64	24.55	912.45	831.60	0.263	0.280		
20 mph	5	1200	1150	5.20	3.75		1485	3.84	5.63	42.14	44.62	20.83	25.48	947.10	820.05	0.855	0.300		
40 hp	9	1300	1400	5.25	3.75	1600	1575	4.00	6.42	46.06	41.75	20.09	23.52	889.35	848.15	0.332	0.560		
	13	1050	1100	5.20	4.70	1650	1575	4.25	6.50	44.60	41.59	21.06	23.93	900.90	820.05	1.182	1.760		
As-measured average		1280	1310	5.25	4.25	1625	1509	4.40	6.49	43.64	42.53	19.91	24.37	912.45	829.96	0.658	0.730		
Adjusted average†		3570	4470	14.60	14.40	4510	5120	12.20	22.0	121.0	144.1	56.40	82.6	2535	2815	1.82	0.248	2.79	3.42
II	2	300	310	4.45	4.00		1420	3.28	4.00	35.11	34.10	19.79	19.03	750.75	762.30	0.574	0.290		
30 mph	6	260	380	4.45	3.95		1465	3.31	4.29	35.28	32.71	20.83	18.13	750.75	727.65	0.676	0.440		
40 hp	10	320	380	4.70	3.95	1530	1510	3.25	4.69	35.68	33.32	21.06	18.60	727.65	750.75	0.890	0.430		
	14	320	380	4.60	3.80	1580	1530	3.27	4.88	37.11	33.99	21.31	18.38	727.65	727.65	1.269	1.250		
As-measured average		300	363	4.55	3.93	1555	1481	3.28	4.47	35.80	33.53	20.75	18.54	739.20	742.09	0.852	0.600		
Adjusted average		985	1435	14.90	14.85	5080	5600	10.75	16.85	11.70	126.5	68.0	70.1	2420	2800	2.79	0.226	3.28	3.78
III	3	220	280	4.40	4.10		1340	3.03	3.13	29.41	32.10	30.88	16.74	623.70	739.20	0.767	0.290		
40 mph	7	220	250	4.40	3.95		1400	1.85	2.67	25.48	28.86	15.62	15.23	646.60	716.10	0.617	0.420		
40 hp	11	220	250	4.45	3.70	1530	1430	2.13	2.75	36.67	30.38	16.54	16.37	612.15	681.45	1.182	0.430		
	15	220	250	4.20	3.70	1440	1460	1.78	3.00	34.10	28.16	15.98	16.91	646.80	669.90	1.136	0.970		
As-measured average		220	258	4.36	3.86	1485	1408	2.20	2.89	31.42	29.88	19.76	16.31	632.36	701.66	0.926	0.530		
Adjusted average		750	995	14.90	14.87	5075	5430	7.5	11.1	107.2	115.1	67.5	63.0	2160	2705	3.16	0.204	3.42	3.86
IV	4	260	300	1.45	1.60		710	2.15	3.13	27.19	27.08	14.70	13.70	265.65	334.95	0.392	0.430		
Idle	8	240	280	1.45	1.40		730	1.98	2.90	25.48	25.01	13.39	12.33	288.75	300.30	0.294	0.420		
	12	300	280	1.60	1.40	640	660	2.00	3.21	28.74	24.50	15.79	13.39	277.20	334.95	0.499	0.850		
	16	220	300	1.45	1.40	600	730	2.01	3.00	26.08	25.25	15.22	15.44	288.75	288.75	0.465	0.970		
As-measured average		255	290	1.49	1.45	620	708	2.04	3.06	26.87	25.46	14.78	13.72	280.09	314.74	0.413	0.670		
Adjusted average		5250	2930	14.75	14.65	6140	7150	20.2	30.9	265.0	257.5	146.2	138.9	2780	3180	4.09	0.677	9.90	10.10

---

*Total as ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 37. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 678
Test Days: 0
Test Mileage: 0

Date: August 19 and 22, 1968
Operating Conditions: See Table 23
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formaldehyde	NO_x	SO_2
I	1	S	A	-	S	A	S	A	A
20 mph	2	A	A	-	S	$S^{(4)}$	S	A	A
40 hp	3	A	A	-	S	$A^{(4)}$	S	A	A
	4	S	A	-	S	$S^{(4)}$	S	A	A
	5	S	S	-	A	$A^{(4)}$	A	A	A
	6	A	S	-	A	A	A	S	S
	7	S	S	-	A	S	A	S	S
	8	A	S	-	A	S	A	S	S
	U_s	7	0	-	0	4	0	0	0
II	1	S	A	-	S	A	A	$S^{(4)}$	A
30 mph	2	S	A	-	S	A	A	$A^{(4)}$	A
40 hp	3	A	A	-	S	A	A	$S^{(4)}$	A
	4	S	A	-	S	A	A	$A^{(4)}$	A
	5	S	S	-	A	S	S	A	S
	6	A	S	-	A	S	S	$S^{(4)}$	S
	7	A	S	-	A	S	S	$A^{(4)}$	S
	8	A	S	-	A	S	S	$S^{(4)}$	S
	U_s	2	0	-	0	0	0	7	0
III	1	S	A	-	S	S	A	S	A
40 mph	2	S	A	-	S	A	S	S	A
40 hp	3	S	A	-	S	A	S	S	A
	4	S	A	-	A	S	A	S	A
	5	A	S	-	A	A	S	A	S
	6	A	S	-	A	A	A	A	S
	7	A	S	-	S	S	A	A	S
	8	A	S	-	A	S	S	A	S
	U_s	0	0	-	3	6	8	0	0
IV	1	S	A	-	S	A	A	S	A
Idle	2	S	A	-	S	A	$S^{(4)}$	S	A
0 hp	3	S	A	-	S	A	$A^{(4)}$	$S^{(4)}$	A
	4	A	S	-	S	S	A	$A^{(4)}$	A
	5	A	S	-	A	S	S	$S^{(4)}$	A
	6	$A^{(4)}$	S	-	A	A	S	A	S
	7	$S^{(4)}$	$S^{(4)}$	-	A	S	A	A	S
	8	$A^{(4)}$	$A^{(4)}$	-	A	S	S	A	S
	U_s	3	3.5	-	0	2	4.5	1	0

(1) "S" stands for EM-70-F untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 38. COMPARISON OF ODOR PANEL RESPONSES FOR ADDITIVE TREATED FUEL VERSUS CODE EM-70-F* INITIAL EVALUATION

Vehicle: Bus 680
Test Months: 0
Test Mileage: 0

Date: August 28 and 29, 1968
Operating Conditions†: See Tables 2 through 5

Operating Conditions	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
I.	Untreated	6.2	2.0	1.9	1.1	1.5
	Treated	6.3	2.0	1.8	0.9	1.3
	Net Change	+0.1	0	-0.1	-0.2	-0.2
II.	Untreated	5.8	1.9	1.8	0.9	1.2
	Treated	6.0	1.8	1.6	1.0	1.1
	Net Change	+0.2	-0.1	-0.2	+0.1	-0.1
III.	Untreated	5.4	1.9	1.6	1.1	0.8
	Treated	5.7	1.8	1.5	1.1	1.0
	Net Change	+0.3	-0.1	-0.1	0	+0.2
IV.	Untreated	6.0	2.0	1.7	0.9	1.4
	Treated	6.4	1.9	1.8	0.9	1.2
	Net Change	+0.4	-0.1	+0.1	0	-0.2
V.	Untreated	6.1	2.0	1.8	1.1	1.3
	Treated	6.2	1.9	1.7	1.0	1.2
	Net Change	+0.1	-0.1	-0.1	-0.1	-0.1

---

*No. 1 Diesel, SwRI supply.

†I. Constant Speed, 20 mph, 40 hp.
II. Constant Speed, 40 mph, 40 hp.
III. Idle after 30 mph, 40-hp cruise.
IV. Acceleration after 1-min idle.
V. Deceleration from 40 mph, 40-hp cruise.

TABLE 39. INITIAL VEHICLE ODOR EVALUATION SUMMARY - CODE EM-70-F* UNTREATED BASE FUEL

Vehicle: Bus 680
Date: August 29, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

		Average Panel Responses				
Run No. †	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	I. Constant Speed	6.2	2.1	1.9	0.9	1.5
7	" "	6.1	2.0	2.0	0.8	1.5
16	" "	6.0	1.9	1.8	1.5	1.3
24	" "	6.5	2.1	1.9	1.2	1.5
		6.2	2.0	1.9	1.1	1.5
1	II. Constant Speed	5.5	1.8	1.7	0.7	0.7
12	" "	5.8	2.0	1.7	0.8	1.3
20	" "	5.8	1.9	1.8	1.0	1.3
22	" "	5.9	2.0	1.8	1.0	1.5
		5.8	1.9	1.8	0.9	1.2
14	III. Idle	5.2	1.8	1.5	1.1	0.4
15	"	5.2	1.7	1.3	1.2	0.9
17	"	5.7	2.0	1.7	1.2	1.0
21	"	5.3	1.9	1.7	1.0	1.0
		5.4	1.9	1.6	1.1	0.8
3	IV. Idle-Acceleration	5.0	1.8	1.3	0.7	1.1
6	" "	5.8	1.9	1.7	0.9	1.3
10	" "	6.2	2.0	1.9	1.0	1.5
23	" "	6.9	2.2	2.0	1.0	1.7
		6.0	2.0	1.7	0.9	1.4
2	V. Deceleration	5.5	1.9	1.7	1.1	1.0
8	"	6.1	2.0	1.8	1.0	1.3
11	"	5.9	1.9	1.8	0.8	1.5
18	"	6.7	2.0	2.0	1.5	1.3
		6.1	2.0	1.8	1.1	1.3

---

*No. 1 Diesel, SwRI supply.

†Runs 5, 9, 13, and 19 were conducted without exhaust sample.

TABLE 39A. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 680
Date: August 29, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses 0	4	5	6	7	Avg
1	Constant Speed			5	5		5.5
2	Deceleration			5	5		5.5
3	Idle-Acceleration		1	8	1		5.0
4	Constant Speed			1	6	3	6.2
5	Blank	10					0
6	Idle-Acceleration			2	8		5.8
7	Constant Speed				9	1	6.1
8	Deceleration				9	1	6.1
9	Blank	10					0
10	Idle-Acceleration				8	2	6.2
11	Deceleration			2	7	1	5.9
12	Constant Speed			2	8		5.8
13	Blank	10					0
14	Idle			8	2		5.2
15	Idle		2	5	2	1	5.2
16	Constant Speed			2	6	2	6.0
17	Idle			3	7		5.7
18	Deceleration				3	7	6.7
19	Blank	10					0
20	Constant Speed			2	8		5.8
21	Idle			7	3		5.3
22	Constant Speed			1	9		5.9
23	Idle-Acceleration				1	9	6.9
24	Constant Speed				5	5	6.5

TABLE 39B. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: August 29, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Avg
1	Constant Speed		2	8		1.8
2	Deceleration		1	9		1.9
3	Idle-Acceleration		2	8		1.8
4	Constant Speed			9	1	2.1
5	Blank	10				0
6	Idle-Acceleration		1	9		1.9
7	Constant Speed			10		2.0
8	Deceleration			10		2.0
9	Blank	10				0
10	Idle-Acceleration			10		2.0
11	Deceleration		1	9		1.9
12	Constant Speed			10		2.0
13	Blank	10				0
14	Idle		2	8		1.8
15	Idle		3	7		1.7
16	Constant Speed		1	9		1.9
17	Idle			10		2.0
18	Deceleration			10		2.0
19	Blank	10				0
20	Constant Speed		1	9		1.9
21	Idle		1	9		1.9
22	Constant Speed			10		2.0
23	Idle-Acceleration			8	2	2.2
24	Constant Speed			9	1	2.1

TABLE 39C. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: August 29, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Avg
1	Constant Speed		3	7	1.7
2	Deceleration		3	7	1.7
3	Idle-Acceleration		7	3	1.3
4	Constant Speed		1	9	1.9
5	Blank	10			0
6	Idle-Acceleration		3	7	1.7
7	Constant Speed			10	2.0
8	Deceleration		2	8	1.8
9	Blank	10			0
10	Idle-Acceleration		1	9	1.9
11	Deceleration		2	8	1.8
12	Constant Speed		3	7	1.7
13	Blank	10			0
14	Idle		5	5	1.5
15	Idle		7	3	1.3
16	Constant Speed		2	8	1.8
17	Idle		3	7	1.7
18	Deceleration			10	2.0
19	Blank	10			0
20	Constant Speed		2	8	1.8
21	Idle		3	7	1.7
22	Constant Speed		2	8	1.8
23	Idle-Acceleration			10	2.0
24	Constant Speed		1	9	1.9

TABLE 39D. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 680
Date: August 29, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Avg
1	Constant Speed	3	7		0.7
2	Deceleration		9	1	1.1
3	Idle-Acceleration	3	7		0.7
4	Constant Speed	2	7	1	0.9
5	Blank	10			0
6	Idle-Acceleration	1	9		0.9
7	Constant Speed	2	8		0.8
8	Deceleration	1	8	1	1.0
9	Blank	10			0
10	Idle-Acceleration	1	8	1	1.0
11	Deceleration	2	8		0.8
12	Constant Speed	2	8		0.8
13	Blank	10			0
14	Idle		9	1	1.1
15	Idle	1	6	3	1.2
16	Constant Speed		5	5	1.5
17	Idle	1	6	3	1.2
18	Deceleration		5	5	1.5
19	Blank	10			0
20	Constant Speed	1	8	1	1.0
21	Idle	1	8	1	1.0
22	Constant Speed	1	8	1	1.0
23	Idle-Acceleration	2	6	2	1.0
24	Constant Speed		8	2	1.2

TABLE 39E. INITIAL VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 680
Date: August 29, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Avg
1	Constant Speed	3	7		0.7
2	Deceleration	1	8	1	1.0
3	Idle-Acceleration		9	1	1.1
4	Constant Speed		5	5	1.5
5	Blank	10			0
6	Idle-Acceleration		7	3	1.3
7	Constant Speed		5	5	1.5
8	Deceleration		7	3	1.3
9	Blank	10			0
10	Idle-Acceleration		5	5	1.5
11	Deceleration		5	5	1.5
12	Constant Speed		7	3	1.3
13	Blank	10			0
14	Idle	7	2	1	0.4
15	Idle	2	7	1	0.9
16	Constant Speed		7	3	1.3
17	Idle	1	8	1	1.0
18	Deceleration		7	3	1.3
19	Blank	10			0
20	Constant Speed		7	3	1.3
21	Idle	2	6	2	1.0
22	Constant Speed		5	5	1.5
23	Idle-Acceleration		3	7	1.7
24	Constant Speed		5	5	1.5

TABLE 40. INITIAL VEHICLE ODOR EVALUATION SUMMARY - ADDITIVE TREATED FUEL

Vehicle: Bus 680
Date: August 28, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-72-F

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	I. Constant Speed	6.1	1.9	1.8	0.9	1.2
7	" "	5.9	1.9	1.7	1.0	1.0
13	" "	6.1	1.9	1.9	0.8	1.3
18	" "	6.9	2.1	1.9	0.9	1.5
		6.3	2.0	1.8	0.9	1.3
2	II. Constant Speed	5.1	1.6	1.2	1.0	0.7
11	" "	6.4	1.8	1.8	0.8	1.2
16	" "	5.8	1.7	1.7	1.0	1.3
22	" "	6.7	2.1	1.8	1.0	1.2
		6.0	1.8	1.6	1.0	1.1
6	III. Idle	5.2	1.7	1.3	0.9	0.8
8	"	5.3	1.6	1.3	1.0	0.9
19	"	6.6	1.9	1.7	1.5	1.0
24	"	5.8	1.9	1.8	0.9	1.3
		5.7	1.8	1.5	1.1	1.0
4	IV. Idle-Acceleration	5.8	1.7	1.7	1.0	1.2
12	" "	6.7	2.0	1.8	1.0	1.2
17	" "	6.8	2.0	1.9	0.8	1.3
23	" "	6.1	1.9	1.9	0.9	1.1
		6.4	1.9	1.8	0.9	1.2
1	V. Deceleration	6.5	1.9	1.9	1.0	1.1
9	"	5.9	1.9	1.7	1.0	1.1
14	"	6.3	1.8	1.5	1.1	1.3
21	"	6.1	1.9	1.5	0.9	1.3
		6.2	1.9	1.7	1.0	1.2

---

*Runs 5, 10, 15, and 20 were conducted without exhaust sample.

TABLE 40A. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Standard)

Vehicle: Bus 680
Date: August 28, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run	Operating	"D" Diesel Composite Responses						
No.	Condition	0	4	5	6	7	8	Avg
1	Deceleration			1	3	6		6.5
2	Constant Speed			9	1			5.1
3	Constant Speed			1	7	2		6.1
4	Idle-Acceleration			3	6	1		5.8
5	Blank	10						0
6	Idle		1	6	3			5.2
7	Constant Speed			1	9			5.9
8	Idle			7	3			5.3
9	Deceleration			2	7	1		5.9
10	Blank	10						0
11	Constant Speed			2	2	6		6.4
12	Idle-Acceleration			1	1	8		6.7
13	Constant Speed			1	7	2		6.1
14	Deceleration			3	1	6		6.3
15	Blank	10						0
16	Constant Speed			3	6	1		5.8
17	Idle-Acceleration				2	8		6.8
18	Constant Speed				1	9		6.9
19	Idle		1		1	8		6.6
20	Blank	10						0
21	Deceleration			1	7	2		6.1
22	Constant Speed			1	2	6	1	6.7
23	Idle-Acceleration			1	7	2		6.1
24	Idle			4	4	2		5.8

TABLE 40B. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: August 28, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Avg
1	Deceleration		1	9		1.9
2	Constant Speed		4	6		1.6
3	Constant Speed		1	9		1.9
4	Idle-Acceleration		3	7		1.7
5	Blank	10				0
6	Idle		3	7		1.7
7	Constant Speed		1	9		1.9
8	Idle		4	6		1.6
9	Deceleration		1	9		1.9
10	Blank	10				0
11	Constant Speed		2	8		1.8
12	Idle-Acceleration		1	8	1	2.0
13	Constant Speed		1	9		1.9
14	Deceleration		2	8		1.8
15	Blank	10				0
16	Constant Speed		3	7		1.7
17	Idle-Acceleration			10		2.0
18	Constant Speed			9	1	2.1
19	Idle		1	9		1.9
20	Blank	10				0
21	Deceleration		1	9		1.9
22	Constant Speed		1	7	2	2.1
23	Idle-Acceleration		1	9		1.9
24	Idle		1	9		1.9

TABLE 40C. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: August 28, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Avg
1	Deceleration		1	9	1.9
2	Constant Speed		8	2	1.2
3	Constant Speed		2	8	1.8
4	Idle-Acceleration		3	7	1.7
5	Blank	10			0
6	Idle		7	3	1.3
7	Constant Speed		3	7	1.7
8	Idle		7	3	1.3
9	Deceleration		3	7	1.7
10	Blank	10			0
11	Constant Speed		2	8	1.8
12	Idle-Acceleration		2	8	1.8
13	Constant Speed		1	9	1.9
14	Deceleration		5	5	1.5
15	Blank	10			0
16	Constant Speed		3	7	1.7
17	Idle-Acceleration		1	9	1.9
18	Constant Speed		1	9	1.9
19	Idle		3	7	1.7
20	Blank	10			0
21	Deceleration		5	5	1.5
22	Constant Speed		2	8	1.8
23	Idle-Acceleration		1	9	1.9
24	Idle		2	8	1.8

TABLE 40D. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 680
Date: August 28, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Avg
1	Deceleration		10		1.0
2	Constant Speed		10		1.0
3	Constant Speed	1	9		0.9
4	Idle-Acceleration		10		1.0
5	Blank	10			0
6	Idle	1	9		0.9
7	Constant Speed		10		1.0
8	Idle		10		1.0
9	Deceleration		10		1.0
10	Blank	10			0
11	Constant Speed	2	8		0.8
12	Idle-Acceleration	1	8	1	1.0
13	Constant Speed	2	8		0.8
14	Deceleration		9	1	1.1
15	Blank	10			0
16	Constant Speed		10		1.0
17	Idle-Acceleration	2	8		0.8
18	Constant Speed	1	9		0.9
19	Idle		5	5	1.5
20	Blank	10			0
21	Deceleration	1	9		0.9
22	Constant Speed		10		1.0
23	Idle-Acceleration	1	9		0.9
24	Idle	1	9		0.9

TABLE 40E. INITIAL VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 680
Date: August 28, 1968

Operating Conditions: See Tables 2 through 5

Fuel: EM-72-F

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Avg
1	Deceleration		9	1	1.1
2	Constant Speed	3	7		0.7
3	Constant Speed		8	2	1.2
4	Idle-Acceleration		8	2	1.2
5	Blank	10			0
6	Idle	2	8		0.8
7	Constant Speed		10		1.0
8	Idle	1	9		0.9
9	Deceleration		9	1	1.1
10	Blank	10			0
11	Constant Speed	1	6	3	1.2
12	Idle-Acceleration		8	2	1.2
13	Constant Speed		7	3	1.3
14	Deceleration		7	3	1.3
15	Blank	10			0
16	Constant Speed		7	3	1.3
17	Idle-Acceleration		7	3	1.3
18	Constant Speed		5	5	1.5
19	Idle	1	8	1	1.0
20	Blank	10			0
21	Deceleration		7	3	1.3
22	Constant Speed		8	2	1.2
23	Idle-Acceleration	1	7	2	1.1
24	Idle		7	3	1.3

TABLE 41. COMPUTATION OF "U" STATISTICS TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS CODE EM 70 F* UNTREATED BASE FUEL

Vehicle: Bus 680
Test Days: 0
Test Mileage: 0

Date: August 28 and 29, 1968
Operating Conditions: See Tables 2 through 5
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"
I 20 mph 40 hp	1	A	A(4)	A	S(4)	A
	2	S(1)	S(4)	S(4)	A(4)	A
	3	A(4)	A(4)	A(4)	A(4)	S(4)
	4	S(4)	A(4)	S(4)	S(4)	A(4)
	5	A(4)	S	A(4)	A(4)	S(4)
	6	S	S(4)	S(4)	A	A(4)
	7	S	A(4)	A(4)	S	S(4)
	8	A(2)	S(4)	S	S	S(4)
	U_s(3)	7	4.5	4.5	5.5	3
II 40 mph 40 hp	1	A	A	A	S	A(4)
	2	S	A	S(4)	A(4)	S(4)
	3	S(4)	S(4)	A(4)	S(4)	A
	4	A(4)	A(4)	S(4)	A(4)	A
	5	S(4)	S	A(4)	S(4)	S(4)
	6	S	S	S(4)	A(4)	A(4)
	7	A	S	A(4)	S(4)	S(4)
	8	A	A	S(4)	A(4)	S
	U_s	6	4.5	7	5.5	4.5
III Idle	1	S(4)	A	A(4)	A	S
	2	A(4)	S(4)	S(4)	A	A
	3	S(4)	A(4)	A(4)	S(4)	S(4)
	4	A(4)	S	S	A(4)	A(4)
	5	S(4)	A(4)	S(4)	S	S(4)
	6	S	S(4)	A(4)	S	A(4)
	7	A	A(4)	S(4)	S	S(4)
	8	A	S	A	A	A
	U_s	4.5	5.5	8	4.5	6.5

Operating Condition	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"
IV Idle- Acceleration	1	S	A	S	S	S(4)
	2	A(4)	S	A(4)	A	A(4)
	3	S(4)	A(4)	S(4)	S(4)	A
	4	A	S(4)	A	A(4)	A
	5	S	A(4)	A(4)	S(4)	S(4)
	6	A	S(4)	S(4)	A(4)	A(4)
	7	A	A(4)	A(4)	S(4)	S
	8	S	S	S	A(4)	S
	U_s	6.5	6.5	7.5	7.5	4
V Deceleration	1	S	A	A	S	S
	2	A(4)	A(4)	A	A	A
	3	S(4)	S(4)	S(4)	A(4)	A
	4	A(4)	A(4)	A(4)	S(4)	S(4)
	5	S(4)	S(4)	S	A(4)	A(4)
	6	A	A(4)	S	A(4)	S(4)
	7	A	S	A	S(4)	A(4)
	8	S	S	S	S	S
	U_s	6	3	3.5	6.5	6

(1) "S" stands for EM-70-F (No. 1 Diesel) untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

---

*No. 1 Diesel, SwRI supply.

TABLE 42. COMPARISON OF ODOR PANEL RESPONSES FOR ADDITIVE TREATED FUEL VERSUS CODE EM-73-F* UNTREATED FUEL

Vehicle: Bus 680

Date: August 28 and 30, 1968
Operating Conditions†: See Tables 2 through 5

Operating Condition†	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
I.	Untreated	6.4	2.1	1.9	1.0	1.7
	Treated	6.3	2.0	1.8	0.9	1.3
	Net Change	-0.1	-0.1	-0.1	-0.1	-0.4
II.	Untreated	6.3	2.0	1.9	1.0	1.3
	Treated	6.0	1.8	1.6	1.0	1.1
	Net Change	-0.3	-0.2	-0.3	0	-0.2
III.	Untreated	6.4	2.0	1.6	1.1	1.3
	Treated	5.7	1.8	1.5	1.1	1.0
	Net Change	-0.7	-0.2	-0.1	0	-0.3
IV.	Untreated	6.3	2.1	2.0	0.9	1.5
	Treated	6.4	1.9	1.8	0.9	1.2
	Net Change	+0.1	-0.2	-0.2	0	-0.3
V.	Untreated	6.1	2.0	1.9	1.0	1.3
	Treated	6.2	1.9	1.7	1.0	1.2
	Net Change	+0.1	-0.1	-0.2	0	-0.1

---

*No. 1 Diesel, S. A. Transit Co. supply.

†I. Constant Speed, 20 mph, 40 hp.
II. Constant Speed, 40 mph, 40 hp.
III. Idle after 30 mph, 40-hp cruise.
IV. Acceleration after 1-min idle.
V. Deceleration from 40 mph, 40-hp cruise.

TABLE 43. VEHICLE ODOR EVALUATION SUMMARY - CODE EM-73-F* UNTREATED FUEL

Vehicle: Bus 680
Date: August 30, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	Average Panel Responses "D" Composite	 "B" Burnt	 "O" Oily	 "A" Aromatic	 "P" Pungent
8	I. Constant Speed	6.6	2.1	1.9	0.9	1.8
11	" "	6.0	2.0	1.8	1.0	1.4
20	" "	6.0	2.0	1.9	1.0	1.7
24	" "	7.0	2.2	2.0	1.2	1.9
		6.4	2.1	1.9	1.0	1.7
1	II. Constant Speed	5.4	1.8	1.6	0.9	0.9
5	" "	6.0	1.9	1.9	0.9	1.0
17	" "	7.1	2.1	2.1	1.1	1.9
21	" "	6.6	2.0	2.0	1.0	1.4
		6.3	2.0	1.9	1.0	1.3
3	III. Idle	6.1	1.8	1.2	1.0	1.1
6	"	5.6	1.9	1.4	1.0	1.1
14	"	6.9	2.2	1.9	1.1	1.4
16	"	6.8	2.1	2.0	1.1	1.4
		6.4	2.0	1.6	1.1	1.3
2	IV. Idle-Acceleration	5.9	2.0	2.0	0.9	1.1
9	" "	6.0	2.0	2.0	0.8	1.2
19	" "	6.9	2.1	2.1	1.1	2.0
22	" "	6.4	2.1	1.9	0.9	1.8
		6.3	2.1	2.0	0.9	1.5
4	V. Deceleration	5.6	1.9	1.6	1.0	0.9
10	"	6.0	2.0	1.8	0.9	1.1
13	"	6.1	2.0	2.0	1.0	1.2
23	"	6.6	2.0	2.0	1.2	1.8
		6.1	2.0	1.9	1.0	1.3

---

*No. 1 Diesel, S. A. Transit Co. supply.

TABLE 43A. VEHICLE ODOR EVALUATION RESULTS - EM-73-F FUEL

("D" Diesel Composite Results)

Vehicle: Bus 680
Date: August 30, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses					
		0	5	6	7	8	Avg
1	Constant Speed		6	4			5.4
2	Idle-Acceleration		1	9			5.9
3	Idle			9	1		6.1
4	Deceleration		4	6			5.6
5	Constant Speed		1	8	1		6.0
6	Idle		4	6			5.6
7	Blank	10					0
8	Constant Speed			4	6		6.6
9	Idle-Acceleration			10			6.0
10	Deceleration		2	6	2		6.0
11	Constant Speed			10			6.0
12	Blank	10					0
13	Deceleration			9	1		6.1
14	Idle			1	9		6.9
15	Blank	10					0
16	Idle			2	8		6.8
17	Constant Speed				9	1	7.1
18	Blank	10					0
19	Idle-Acceleration			2	7	1	6.9
20	Constant Speed			10			6.0
21	Constant Speed			4	6		6.6
22	Idle-Acceleration			6	4		6.4
23	Deceleration			4	6		6.6
24	Constant Speed			1	8	1	7.0

TABLE 43B. VEHICLE ODOR EVALUATION RESULTS - EM-73-F FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: August 30, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Avg
1	Constant Speed		2	8		1.8
2	Idle-Acceleration			10		2.0
3	Idle		2	8		1.8
4	Deceleration		1	9		1.9
5	Constant Speed		1	9		1.9
6	Idle		1	9		1.9
7	Blank	10				0
8	Constant Speed			9	1	2.1
9	Idle-Acceleration			10		2.0
10	Deceleration			10		2.0
11	Constant Speed			10		2.0
12	Blank	10				0
13	Deceleration			10		2.0
14	Idle			8	2	2.2
15	Blank	10				0
16	Idle			9	1	2.1
17	Constant Speed			9	1	2.1
18	Blank	10				0
19	Idle-Acceleration			9	1	2.1
20	Constant Speed			10		2.0
21	Constant Speed			10		2.0
22	Idle-Acceleration			9	1	2.1
23	Deceleration			10		2.0
24	Constant Speed			8	2	2.2

TABLE 43C. VEHICLE ODOR EVALUATION RESULTS - EM-73-F FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: August 30, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses				
		0	1	2	0	Avg
1	Constant Speed		4	6		1.6
2	Idle-Acceleration			10		2.0
3	Idle		8	2		1.2
4	Deceleration		4	6		1.6
5	Constant Speed		1	9		1.9
6	Idle		6	4		1.4
7	Blank	10				0
8	Constant Speed		1	9		1.9
9	Idle-Acceleration			10		2.0
10	Deceleration		2	8		1.8
11	Constant Speed		2	8		1.8
12	Blank	10				0
13	Deceleration			10		2.0
14	Idle		1	9		1.9
15	Blank	10				0
16	Idle			10		2.0
17	Constant Speed			9	1	2.1
18	Blank	10				0
19	Idle-Acceleration			9	1	2.1
20	Constant Speed		1	9		1.9
21	Constant Speed			10		2.0
22	Idle-Acceleration		1	9		1.9
23	Deceleration			10		2.0
24	Constant Speed			10		2.0

TABLE 43D. VEHICLE ODOR EVALUATION RESULTS - EM-73-F FUEL

("A" Aromatic Standard)

Vehicle: Bus 680
Date: August 30, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Avg
1	Constant Speed	1	9		0.9
2	Idle-Acceleration	1	9		0.9
3	Idle	1	8	1	1.0
4	Deceleration	1	8	1	1.0
5	Constant Speed	1	9		0.9
6	Idle	1	8	1	1.0
7	Blank	10			0
8	Constant Speed	1	9		0.9
9	Idle-Acceleration	2	8		0.8
10	Deceleration	1	9		0.9
11	Constant Speed		10		1.0
12	Blank	10			0
13	Deceleration		10		1.0
14	Idle		9	1	1.1
15	Blank	10			0
16	Idle		9	1	1.1
17	Constant Speed		9	1	1.1
18	Blank	10			0
19	Idle-Acceleration		9	1	1.1
20	Constant Speed		10		1.0
21	Constant Speed		10		1.0
22	Idle-Acceleration	1	9		0.9
23	Deceleration		8	2	1.2
24	Constant Speed		8	2	1.2

TABLE 43E. VEHICLE ODOR EVALUATION RESULTS - EM-73-F FUEL

("P" Pungent Standard)

Vehicle: Bus 680
Date: August 30, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	Constant Speed	1	9		0.9
2	Idle-Acceleration		9	1	1.1
3	Idle	1	7	2	1.1
4	Deceleration	1	9		0.9
5	Constant Speed		10		1.0
6	Idle		9	1	1.1
7	Blank	10			0
8	Constant Speed		2	8	1.8
9	Idle-Acceleration		8	2	1.2
10	Deceleration	1	7	2	1.1
11	Constant Speed		6	4	1.4
12	Blank	10			0
13	Deceleration		8	2	1.2
14	Idle		6	4	1.4
15	Blank	10			0
16	Idle		6	4	1.4
17	Constant Speed		1	9	1.9
18	Blank	10			0
19	Idle-Acceleration			10	2.0
20	Constant Speed		3	7	1.7
21	Constant Speed		6	4	1.4
22	Idle-Acceleration		2	8	1.8
23	Deceleration		2	8	1.8
24	Constant Speed		1	9	1.9

TABLE 44 COMPUTATION OF "U" STATISTICS TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS CODE EM 73 F* UNTREATED FUEL

Vehicle: Bus 680

Date: August 28 and 30, 1968
Operating Conditions: See Tables 2 through 5

Operating Condition	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
I 20 mph 40 hp	1	A	A	A	A	A
	2	S	A	$S^{(4)}$	$A^{(4)}$	A
	3	S	A	$A^{(4)}$	$S^{(4)}$	A
	4	A	S	$A^{(4)}$	$A^{(4)}$	S
	5	A	S	$S^{(4)}$	$S^{(4)}$	A
	6	S	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	S
	7	A	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	S
	8	S	S	S	S	S
	U_s	7	2.5	4.5	3	1
II 40 mph 40 hp	1	A	A	A	A	A
	2	S	A	S	S	S
	3	A	$S^{(4)}$	A	S	S
	4	S	$A^{(4)}$	A	$A^{(4)}$	A
	5	A	S	A	$S^{(4)}$	A
	6	S	S	S	$A^{(4)}$	A
	7	A	$A^{(4)}$	S	$A^{(4)}$	S
	8	S	$S^{(4)}$	S	S	S
	U_s	6	4	3	7.5	6
III Idle	1	A	A	S	A	A
	2	A	A	A	A	A
	3	S	S	A	$S^{(4)}$	A
	4	A	$A^{(4)}$	S	$A^{(4)}$	S
	5	S	$S^{(4)}$	A	$S^{(4)}$	S
	6	A	$A^{(4)}$	A	S	A
	7	S	S	S	S	S
	8	S	S	S	A	S
	U_s	3	3	6	5	2
IV Idle- Acceleration	1	A	A	A	$A^{(4)}$	$A^{(4)}$
	2	S	A	A	$S^{(4)}$	$S^{(4)}$
	3	S	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$
	4	A	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$
	5	S	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$
	6	A	$A^{(4)}$	S	A	A
	7	A	S	S	A	S
	8	S	S	S	S	S
	U_s	8	2	1	7.5	5.5
V Deceleration	1	S	A	A	$A^{(4)}$	S
	2	A	$A^{(4)}$	A	$S^{(4)}$	$A^{(4)}$
	3	S	$A^{(4)}$	S	$A^{(4)}$	$S^{(4)}$
	4	$A^{(4)}$	$S^{(4)}$	A	$S^{(4)}$	$A^{(4)}$
	5	$S^{(4)}$	$A^{(4)}$	S	$A^{(4)}$	S
	6	A	S	A	$S^{(4)}$	A
	7	A	S	S	A	A
	8	S	S	S	S	S
	U_s	6.5	1.5	3	7.5	7

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

---

*No. 1 Diesel, S. A. Transit Co. supply.

TABLE 45. INITIAL COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS CODE EM-70-F* UNTREATED FUEL

Vehicle: Bus 680
Test Days: 0
Test Mileage: 0

Date: August 28 and 29, 1968
Operating Conditions: See Tables 21 and 22
Base Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
			Max	Min	Avg
A. Untreated	20	44	13	12	12.3
Treated	20	43	11	10	10.3
Net Change					-2.0
B. Untreated	25	54	10	10	10.0
Treated	25	54	9	8	8.3
Net Change					-1.7
C. Untreated	30	66	9	8	8.7
Treated	30	67	7	7	7.0
Net Change					-1.7
D. Untreated	35	75	8	6	7.0
Treated	35	75	6	6	6.0
Net Change					-1.0

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of engine			
Untreated	8	6	7.0
Treated	11	8	9.7
Net Change			+2.7
During acceleration			
Untreated	7	5	6.0
Treated	6	5	5.7
Net Change			-0.3
After upshift			
Untreated	7	7	7.0
Treated	6	6	6.0
Net Change			-1.0

---

*No. 1 Diesel, SwRI supply.

TABLE 46. COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS CODE EM-73-F* UNTREATED FUEL

Vehicle: Bus 680
Date: August 28 and 30, 1968

Operating Conditions: See Tables 21 and 22

Constant Speed Results (all open-rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
			Max	Min	Avg
A. Untreated	20	44	14	13	13.3
Treated	20	43	11	10	10.3
Net Change					-3.0
B. Untreated	25	55	11	10	10.3
Treated	25	54	9	8	8.3
Net Change					-2.0
C. Untreated	30	66	9	8	8.7
Treated	30	67	7	7	7.0
Net Change					-1.7
D. Untreated	35	75	8	7	7.3
Treated	35	75	6	6	6.0
Net Change					-1.3

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of engine			
Untreated	8	7	7.3
Treated	11	8	9.7
Net Change			+2.4
During acceleration			
Untreated	8	6	7.0
Treated	6	5	5.7
Net Change			-1.3
After upshift			
Untreated	8	7	7.7
Treated	6	6	6.0
Net Change			-1.7

---

*No. 1 Diesel, S. A. Transit Co. supply.

TABLE 47 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS CODE EM 70 F* UNTREATED FUEL

Vehicle: Bus 680
Date: August 27 and September 4, 1968

Operating Conditions: See Table 23

Operating Condition	Run No.	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic† Aldehyde, ppm		Formaldehyde, ppm		NO_x, ppm		SO_2, ppm		Adjusting Factor‡	
		Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	1	1750	1550	4.80	4.40	1,930	1,785	6.05	3.09	37.66	36.50	16.54	20.84	693.00	773.85	0.677	0.292		
20 mph	5	1800	1500	4.75	4.05	2,020	1,910	3.30	2.88	46.64	39.12	24.70	22.07	681.45	762.30	1.243	1.168		
40 hp	9	1800	1600	4.65	4.05	2,020	1,900	6.13	5.68	36.11	39.55	19.03	23.16	693.00	785.40	1.411	1.108		
	13	1490	1200	4.60	4.05	1,960	2,030	4.78	7.00	25.77	45.59	12.78	24.06	681.45	796.95	1.420	0.554		
As-measured average		1710	1463	4.70	4.14	1,983	1,906	5.07	4.64	36.55	40.19	18.26	22.53	687.23	779.63	1.188	0.781		
Adjusted average‡		5267	5121	14.48	14.49	6,108	6,671	15.62	16.24	112.57	140.67	56.24	78.86	2116.67	2728.71	36.615	2.73	3.08	3.50
II	2	350	250	4.35	3.70	2,060	1,810	5.72	4.57	34.69	26.76	19.55	17.30	681.45	739.20	0.888	0.868		
30 mph	6	310	270	4.20	3.70	1,960	2,030	3.60	3.96	38.53	34.10	21.62	16.74	669.90	716.10	0.776	0.748		
40 hp	10	300	270	4.10	3.70	1,960	2,080	4.25	3.21	35.49	30.38	16.98	16.37	681.42	739.20	0.129	1.349		
	14	300	300	4.10	3.70	2,060	2,050	3.88	3.88	24.07	30.09	11.42	16.74	669.90	727.65	1.226	0.970		
As-measured average		315	273	4.19	3.70	2,010	1,993	3.89	3.91	33.20	30.33	17.39	16.79	675.68	730.54	0.755	0.984		
Adjusted average		1121	1097	14.92	14.87	7,156	8,012	13.85	15.72	118.19	121.93	61.91	67.50	2405.42	2936.77	2.688	3.96	3.56	4.02
III	3	250	245	4.20	3.80	1,930	1,765	2.64	4.38	30.72	29.73	8.27	16.54	600.60	646.80	0.923	1.037		
40 mph	7	250	230	4.10	3.80	1,920	1,910	2.72	4.59	31.71	30.90	13.54	15.98	589.05	658.35	1.114	1.043		
40 hp	11	275	250	4.20	3.80	1,920	2,080	3.03	2.88	30.42	26.76	17.76	15.79	600.60	635.25	1.142	1.287		
	15	250	260	4.10	3.20	1,960	1,860	2.71	3.91	24.07	30.90	12.18	15.98	589.05	658.35	1.211	1.264		
As-measured average		256	246	4.15	3.65	1,333	1,904	2.78	3.94	29.23	29.57	12.94	16.07	594.33	649.69	1.098	1.143		
Adjusted average		919	1006	14.90	14.93	4,785	7,787	9.98	16.11	104.94	120.94	46.45	65.73	2133.64	2657.23	3.942	4.67	3.59	4.09
IV	4	235	200	1.10	1.0	1,050	1,120	3.27	4.57	29.09	23.78	22.83	12.03	265.65	288.75	0.385	0.426		
Idle	8	235	250	1.10	1.0	1,050	1,810	5.09	4.20	28.74	43.13	22.56	28.16	277.20	277.20	0.199	0.097		
	12	235	270	1.10	1.1	1,100	1,910	3.34	1.92	20.81	53.51	15.04	29.33	265.65	288.25	0.049	1.164		
	16	235	250	1.10	1.0	1,050	1,145	5.30	3.25	26.08	26.76	22.83	24.06	265.65	288.25	0.214	0.429		
As-measured average		235	243	1.10	1.05	1,063	1,496	4.25	3.49	26.18	36.80	20.82	23.40	268.54	285.61	0.212	0.529		
Adjusted average		3137	3390	14.69	14.65	14,191	20,869	56.74	48.69	349.50	513.36	277.95	326.43	3585.01	3984.26	2.83	7.38	13.35	13.95

---

*No. 1 Diesel, SwRI supply.

†Total as ppm formaldehyde.

‡Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 48. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS CODE EM-70-F* UNTREATED FUEL

Vehicle: Bus 680
Test Days: 0
Test Mileage: 0

Date: August 27 and September 4, 1968
Operating Conditions: See Table 23

Operating Condition	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formaldehyde	NO_x	SO_2
I	1	A	A(2)	A	A	S	S	S	A
20 mph	2	S	A	A	A	S	S	S	A
40 hp	3	A	A	A	S	A	S	S	S
	4	A	A	S	S	S	A	S	A
	5	A	S	S	A	A	A	A	A
	6	S(1)	S	S	S	A	A	A	S
	7	S	S	S	S	A	A	A	S
	8	S	S	A	A	S	S	A	S
	U_s(3)	3	0	4	6	5	4	0	2
II	1	A	A	A	A	S	S	S	S
30 mph	2	A	A	S	S	A	A	S	A
40 hp	3	A	A	S	S	A	A	S	S
	4	S(4)	A	A	A(4)	A	A	S	A
	5	A(4)	S	A	S(4)	A	S	A	S
	6	S(4)	S	S	A	S	A	A	A
	7	S	S	S	S	S	S	A	S
	8	S	S	A	A	S	S	A	A
	U_s	1	0	8	6.5	4	5	0	6
III	1	A	A	A	S	S	S	S	S
40 mph	2	A	A	A	S	A	S	S	A
40 hp	3	S(4)	A	A	S	A	S	S	A
	4	S(4)	A	S	A	S	A	S	S
	5	A(4)	S	S	S	S	A	A	S
	6	S(4)	S	S	A	A	A	A	A
	7	A	S	S	A	A	A	A	S
	8	S	S	A	A	S	S	A	A
	U_s	4.5	0	4	1	8	4	0	7
IV	1	A	A	S	A	S	A	S	S
Idle	2	S	A	S	A	A	S	S	A
0 hp	3	S	S(4)	S	S	S	S	S	S
	4	S	S(4)	S	S	A	S	S(4)	S
	5	S	A(4)	A	A	S	S	A(4)	S
	6	A	A(4)	A	A	S	A	A	A
	7	A	S(4)	A	S	A	A	A	A
	8	A	S(4)	A	S	A	A	A	A
	U_s	4	4	0	4	5	4	0.5	3

(1) "S" stands for EM-70-F untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

---

*No. 1 Diesel, SwRI supply.

TABLE 49. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS CODE EM-73-F* UNTREATED FUEL

Vehicle: Bus 680
Date: August 27 and September 3, 1968

Operating Conditions: See Table 23

Operating Condition	Run No.	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic† Aldehyde, ppm		Formaldehyde, ppm		NO_x, ppm		SO_2, ppm		Adjusting Factor‡	
		Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	1	900	1550	4.10	4.40	1,860	1,735	4.82	3.09	32.71	36.50	16.68	20.84	750.75	773.85	1.043	0.292		
20 mph	5	1550	1500	4.10	4.05	1,910	1,910	3.50	2.88	22.68	39.12	8.62	22.07	762.30	762.30	1.195	1.168		
40 hp	9	1650	1600	3.95	4.05	1,930	1,900	3.41	5.68	39.20	39.55	17.86	23.16	750.75	785.40	1.396	1.108		
	13	1450	1200	4.10	4.05	1,860	2,030	3.53	7.00	29.13	45.59	10.29	24.06	762.30	796.95	1.353	0.554		
As-measured average		1388	1463	4.06	4.14	1,890	1,906	3.82	4.64	30.93	40.19	13.36	22.53	756.53	779.63	1.247	0.781		
Adjusted average		4969	5121	14.53	14.49	6,766	6,671	13.68	16.24	110.73	140.67	47.83	78.86	2708.38	2728.71	4.464	2.73	3.58	3.50
II	2	300	250	3.95	3.70	2,000	1,810	3.85	4.57	26.94	26.76	10.88	17.30	658.35	739.20	0.973	0.868		
30 mph	6	300	270	3.40	3.70	2,000	2,030	3.00	3.96	24.57	34.10	7.90	16.74	681.45	716.10	1.098	0.748		
40 hp	10	310	270	3.30	3.70	1,880	2,080	3.16	3.21	31.71	30.38	15.79	16.37	658.35	739.20	1.156	1.349		
	14	310	300	3.30	3.70	1,910	2,050	3.43	3.88	31.36	30.09	13.39	16.74	681.45	727.65	1.128	0.970		
As-measured average		305	273	3.49	3.70	1,948	1,993	3.36	3.91	28.65	30.33	11.99	16.79	669.90	730.54	1.089	0.984		
Adjusted average		1299	1100	14.87	14.91	8,298	8,032	14.31	15.76	122.05	122.23	51.08	67.66	2853.77	2944.08	4.639	3.97	4.26	4.03
III	3	270	245	3.70	3.80	1,880	1,765	2.73	4.38	31.07	29.73	11.76	16.54	623.70	646.80	0.862	1.037		
40 mph	7	250	230	3.40	3.80	1,930	1,910	2.50	4.59	35.28	30.90	16.37	15.98	658.35	658.35	0.910	1.043		
40 hp	11	240	250	3.40	3.80	1,860	2,080	3.20	2.88	37.52	26.76	12.35	15.79	635.25	635.25	1.100	1.287		
	15	270	260	3.30	3.20	1,860	1,860	2.43	3.91	31.36	30.90	11.90	15.98	635.25	658.35	1.083	1.204		
As-measured average		258	246	3.45	3.65	1,883	1,904	2.72	3.94	33.81	29.57	13.10	16.07	638.14	649.69	0.989	1.143		
Adjusted average		1112	1006	14.87	14.93	8,116	7,787	11.72	16.11	145.72	120.94	56.46	65.73	2750.38	2657.23	4.263	4.67	4.31	4.09
IV	4	270	200	1.10	1.0	1,050	1,120	5.19	4.57	26.94	23.78	10.15	12.03	242.55	288.75	0.471	0.426		
Idle	8	270	250	1.00	1.1	960	1,810	5.25	4.20	28.42	43.13	13.39	28.16	254.10	277.20	0.473	0.097		
	12	250	270	0.90	1.1	1,050	1,910	5.43	1.92	26.46	53.51	11.49	29.33	265.65	288.25	0.504	1.164		
	16	260	250	0.90	1.0	1,050	1,145	5.30	3.25	28.42	26.76	10.42	24.06	277.20	288.25	0.423	0.429		
As-measured average		263	243	0.98	1.05	1,028	1,496	5.29	3.49	27.56	36.80	11.30	23.40	259.88	285.61	0.468	0.529		
Adjusted average		3927	3390	14.63	14.65	15,348	20,869	78.98	48.69	411.47	513.36	168.71	326.43	388[illegible]1	3984.26	6.987	7.38	14.93	13.95

---

*No. 1 Diesel, S. A. Transit Co.

†Total as ppm formaldehyde.

‡Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 50. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS CODE EM-73-F* UNTREATED FUEL

Vehicle: Bus 680
Test Days: 0
Test Mileage: 0

Date: August 27 and 30, 1968
Operating Conditions: See Table 23
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Condition	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formaldehyde	NO_x	SO_2
I 20 mph 40 hp	1	$S^{(1)}$	S	A	A	S	S	S	A
	2	$A^{(2)}$	A	S	A	S	S	S	A
	3	S	A	S	S	S	S	$S^{(4)}$	S
	4	A	A	A	S	A	S	$A^{(4)}$	A
	5	$S^{(4)}$	S	$S^{(4)}$	S	A	A	$S^{(4)}$	A
	6	$A^{(4)}$	S	$A^{(4)}$	S	S	A	A	S
	7	A	S	S	A	A	A	A	S
	8	S	A	A	A	A	A	A	S
	$U_s{}^{(3)}$	7.5	7	7.5	8	2	0	1	2
II 30 mph 40 hp	1	A	S	A	S	S	S	S	A
	2	A	S	S	S	A	S	S	A
	3	A	S	S	A	S	S	S	A
	4	$A^{(4)}$	A	S	S	A	S	S	S
	5	$S^{(4)}$	A	S	S	A	A	A	S
	6	$S^{(4)}$	A	A	A	S	A	A	S
	7	S	A	A	A	S	A	A	S
	8	S	S	A	A	A	A	A	A
	U_s	1	4	4	2	7	0	0	4
III 40 mph 40 hp	1	A	A	A	S	A	S	S	S
	2	S	S	$S^{(4)}$	S	A	S	$S^{(4)}$	S
	3	A	S	$A^{(4)}$	S	A	S	$A^{(4)}$	A
	4	$S^{(4)}$	S	$S^{(4)}$	A	A	A	$S^{(4)}$	A
	5	$A^{(4)}$	S	S	S	S	A	A	S
	6	A	A	A	A	S	A	$A^{(4)}$	S
	7	S	A	S	A	S	S	$S^{(4)}$	A
	8	S	A	A	A	S	A	$A^{(4)}$	A
	U_s	4.5	4	8	1	0	3	4	4
IV Idle 0 hp	1	A	S	S	A	A	S	S	A
	2	$A^{(4)}$	S	S	A	S	S	S	S
	3	$S^{(4)}$	$A^{(4)}$	S	A	A	S	S	A
	4	$A^{(4)}$	$S^{(4)}$	S	A	S	A	$A^{(4)}$	A
	5	S	$A^{(4)}$	A	S	S	S	$S^{(4)}$	S
	6	$S^{(4)}$	$A^{(4)}$	A	S	S	A	A	S
	7	$A^{(4)}$	$S^{(4)}$	A	S	A	A	A	S
	8	$S^{(4)}$	$A^{(4)}$	A	S	A	A	A	A
	U_s	4	4	0	0	7	1	0.5	[illegible]

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-70-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

---

*No. 1 Diesel, S. A. Transit Co. supply.

INTERIM INSPECTION

Smoke and Odor Only

Preceding page blank

TABLE 51. COMPARISON OF ODOR PANEL RESPONSES FOR TREATED FUEL VERSUS UNTREATED FUEL-INTERIM EVALUATION

Vehicle: Bus 676
Test Months: 3
Test Mileage: 10,610

Date: November 14 and 15, 1968
Operating Conditions: See Tables 2 through 5

Operating Condition	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Untreated	6.0	1.8	1.5	1.2	1.1
	Treated	5.3	1.5	1.4	1.1	1.0
	Net Change	-0.7	-0.3	-0.1	-0.1	-0.1
30 mph at 40 hp	Untreated	5.5	1.7	1.4	1.1	1.0
	Treated	5.5	1.7	1.5	1.0	0.9
	Net Change	0	0	+0.1	-0.1	-0.1
40 mph at 40 hp	Untreated	5.8	1.7	1.4	1.2	1.0
	Treated	6.1	1.9	1.7	1.0	1.0
	Net Change	+0.3	+0.2	+0.3	-0.2	0
Idle	Untreated	5.2	1.5	1.1	1.3	1.0
	Treated	5.7	1.8	1.3	1.4	0.9
	Net Change	+0.5	+0.3	+0.2	+0.1	-0.1
Idle-Acceleration	Untreated	6.5	2.2	1.8	1.3	1.3
	Treated	6.1	2.0	1.6	1.1	1.1
	Net Change	-0.4	-0.2	-0.2	-0.2	-0.2
Deceleration	Untreated	4.9	1.4	1.1	1.2	0.8
	Treated	4.8	1.3	1.1	1.1	0.5
	Net Change	-0.1	-0.1	0	-0.1	-0.3

TABLE 52. INTERIM VEHICLE ODOR EVALUATION SUMMARY - UNTREATED BASE FUEL

Vehicle: Bus 676
Date: November 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
8	20 mph at 40 hp	6.2	2.0	1.5	1.3	1.2
11	" "	5.8	1.7	1.5	1.1	1.0
20	" "	5.8	1.6	1.5	1.1	1.1
24	" "	6.1	1.8	1.5	1.1	1.0
		6.0	1.8	1.5	1.2	1.1
7	30 mph at 40 hp	5.5	1.8	1.5	0.9	0.9
12	" "	5.5	1.7	1.3	1.2	1.1
15	" "	5.5	1.6	1.4	1.1	1.0
18	" "	5.5	1.5	1.2	1.3	1.1
		5.5	1.7	1.4	1.1	1.0
1	40 mph at 40 hp	5.3	1.6	1.4	1.0	1.0
5	" "	6.0	1.8	1.6	1.4	1.0
17	" "	5.9	1.6	1.4	1.3	0.9
21	" "	5.9	1.7	1.3	1.0	1.0
		5.8	1.7	1.4	1.2	1.0
3	Idle	4.9	1.4	1.1	1.2	0.9
6	"	5.3	1.4	1.1	1.3	1.0
14	"	5.3	1.7	1.1	1.3	1.0
16	"	5.3	1.5	1.1	1.3	1.0
		5.2	1.5	1.1	1.3	1.0
2	Idle-Acceleration	5.9	2.0	1.6	1.0	1.3
9	" "	6.0	2.0	1.7	1.3	1.0
19	" "	7.4	2.4	1.8	1.7	1.7
22	" "	6.8	2.2	2.0	1.2	1.2
		6.5	2.2	1.8	1.3	1.3
4	Deceleration	4.5	1.3	1.0	1.0	0.9
10	"	5.0	1.4	1.0	1.2	0.7
13	"	4.8	1.4	1.1	1.4	0.5
23	"	5.4	1.6	1.1	1.1	1.0
		4.9	1.4	1.1	1.2	0.8

TABLE 52A. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: November 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run	Operating	"D" Diesel Composite Responses					
No.	Condition	4	5	6	7	8	Avg
1	40 mph at 40 hp	1	6	3			5.3
2	Idle-Acceleration		4	3	3		5.9
3	Idle	2	7	1			4.9
4	Deceleration	5	5				4.5
5	40 mph at 40 hp		2	6	2		6.0
6	Idle		7	3			5.3
7	30 mph at 40 hp		5	5			5.5
8	20 mph at 40 hp			8	2		6.2
9	Idle-Acceleration			10			6.0
10	Deceleration	1	8	1			5.0
11	20 mph at 40 hp		2	8			5.8
12	30 mph at 40 hp		6	3	1		5.5
13	Deceleration	4	4	2			4.8
14	Idle		7	3			5.3
15	30 mph at 40 hp		5	5			5.5
16	Idle	1	6	2	1		5.3
17	40 mph at 40 hp		2	7	1		5.9
18	30 mph at 40 hp		5	5			5.5
19	Idle-Acceleration				6	4	7.4
20	20 mph at 40 hp		3	6	1		5.8
21	40 mph at 40 hp		3	5	2		5.9
22	Idle-Acceleration			2	8		6.8
23	Deceleration		6	4			5.4
24	20 mph at 40 hp		2	5	3		6.1

TABLE 52B. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: November 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Avg
1	40 mph at 40 hp		4	6		1.6
2	Idle-Acceleration		1	8	1	2.0
3	Idle		6	4		1.4
4	Deceleration		7	3		1.3
5	40 mph at 40 hp		2	8		1.8
6	Idle		6	4		1.4
7	30 mph at 40 hp		2	8		1.8
8	20 mph at 40 hp			10		2.0
9	Idle-Acceleration			10		2.0
10	Deceleration		6	4		1.4
11	20 mph at 40 hp		3	7		1.7
12	30 mph at 40 hp		3	7		1.7
13	Deceleration	2	4	4		1.4
14	Idle		3	7		1.7
15	30 mph at 40 hp		4	6		1.6
16	Idle		5	5		1.5
17	40 mph at 40 hp		4	6		1.6
18	30 mph at 40 hp		5	5		1.5
19	Idle-Acceleration			6	4	2.4
20	20 mph at 40 hp		4	6		1.6
21	40 mph at 40 hp		3	7		1.7
22	Idle-Acceleration			8	2	2.2
23	Deceleration		4	6		1.6
24	20 mph at 40 hp		2	8		1.8

TABLE 52C. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 676
Date: November 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses				
		0	1	2	3	Avg
1	40 mph at 40 hp		6	4		1.4
2	Idle-Acceleration		4	6		1.6
3	Idle	1	7	2		1.1
4	Deceleration	1	8	1		1.0
5	40 mph at 40 hp		4	6		1.6
6	Idle	1	7	2		1.1
7	30 mph at 40 hp		5	5		1.5
8	20 mph at 40 hp		5	5		1.5
9	Idle-Acceleration		3	7		1.7
10	Deceleration	1	8	1		1.0
11	20 mph at 40 hp		5	5		1.5
12	30 mph at 40 hp		7	3		1.3
13	Deceleration		9	1		1.1
14	Idle		9	1		1.1
15	30 mph at 40 hp		6	4		1.4
16	Idle		9	1		1.1
17	40 mph at 40 hp		6	4		1.4
18	30 mph at 40 hp		8	2		1.2
19	Idle-Acceleration		2	8		1.8
20	20 mph at 40 hp		5	5		1.5
21	40 mph at 40 hp		7	3		1.3
22	Idle-Acceleration		1	8	1	2.0
23	Deceleration		9	1		1.1
24	20 mph at 40 hp		5	5		1.5

TABLE 52D. INTERIM VEHICLE ODOR EVALUATION RESULTS-UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: November 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Avg
1	40 mph at 40 hp		10		1.0
2	Idle-Acceleration		10		1.0
3	Idle	1	6	3	1.2
4	Deceleration	1	8	1	1.0
5	40 mph at 40 hp		6	4	1.4
6	Idle		7	3	1.3
7	30 mph at 40 hp	1	9		0.9
8	20 mph at 40 hp	1	5	4	1.3
9	Idle-Acceleration		7	3	1.3
10	Deceleration	1	6	3	1.2
11	20 mph at 40 hp	1	7	2	1.1
12	30 mph at 40 hp		8	2	1.2
13	Deceleration		6	4	1.4
14	Idle		7	3	1.3
15	30 mph at 40 hp	1	7	2	1.1
16	Idle		7	3	1.3
17	40 mph at 40 hp		7	3	1.3
18	30 mph at 40 hp		7	3	1.3
19	Idle-Acceleration		3	7	1.7
20	20 mph at 40 hp		9	1	1.1
21	40 mph at 40 hp		10		1.0
22	Idle-Acceleration		8	2	1.2
23	Deceleration		9	1	1.1
24	20 mph at 40 hp		9	1	1.1

TABLE 52E. INTERIM VEHICLE ODOR EVALUATION RESULTS-UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: November 15, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	40 mph at 40 hp		10		1.0
2	Idle-Acceleration		7	3	1.3
3	Idle	1	9		0.9
4	Deceleration	1	9		0.9
5	40 mph at 40 hp	1	8	1	1.0
6	Idle		10		1.0
7	30 mph at 40 hp	1	9		0.9
8	20 mph at 40 hp		8	2	1.2
9	Idle-Acceleration		10		1.0
10	Deceleration	3	7		0.7
11	20 mph at 40 hp		10		1.0
12	30 mph at 40 hp	1	7	2	1.1
13	Deceleration	5	5		0.5
14	Idle		10		1.0
15	30 mph at 40 hp		10		1.0
16	Idle		10		1.0
17	40 mph at 40 hp	1	9		0.9
18	30 mph at 40 hp		9	1	1.1
19	Idle-Acceleration		3	7	1.7
20	20 mph at 40 hp		9	1	1.1
21	40 mph at 40 hp		10		1.0
22	Idle-Acceleration	1	6	3	1.2
23	Deceleration		10		1.0
24	20 mph at 40 hp		10		1.0

TABLE 53. INTERIM VEHICLE ODOR EVALUATION SUMMARY - ADDITIVE TREATED FUEL

Vehicle: Bus 676
Date: November 14, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	Average Panel Responses "D" Composite	 "B" Burnt	 "O" Oily	 "A" Aromatic	 "P" Pungent
5	20 mph at 40 hp	5.0	1.2	1.2	1.0	0.9
8	" "	5.4	1.5	1.4	1.0	0.9
18	" "	5.7	1.9	1.6	1.2	1.0
20	" "	5.2	1.5	1.2	1.1	1.0
		5.3	1.5	1.4	1.1	1.0
4	30 mph at 40 hp	5.2	1.7	1.4	0.9	0.8
9	" "	5.8	1.9	1.5	1.0	1.0
12	" "	5.4	1.6	1.4	1.2	0.9
19	" "	5.5	1.6	1.5	1.0	0.9
		5.5	1.7	1.5	1.0	0.9
1	40 mph at 40 hp	5.9	1.8	1.6	0.9	0.9
3	" "	5.6	1.9	1.7	1.0	0.7
10	" "	6.0	1.9	1.8	1.0	0.9
23	" "	6.7	2.1	1.8	1.2	1.4
		6.1	1.9	1.7	1.0	1.0
2	Idle	5.2	1.7	1.2	1.0	0.7
11	"	5.7	1.6	1.4	1.5	0.8
17	"	5.5	1.9	1.2	1.6	0.8
24	"	6.3	2.1	1.5	1.5	1.1
		5.7	1.8	1.3	1.4	0.9
6	Idle-Acceleration	6.1	2.0	1.6	0.8	1.1
14	" "	6.0	2.0	1.5	1.2	1.1
16	" "	5.9	1.7	1.5	1.1	1.1
22	" "	6.4	2.1	1.7	1.2	1.2
		6.1	2.0	1.6	1.1	1.1
7	Deceleration	5.1	1.6	1.1	1.0	0.5
13	"	5.3	1.5	1.2	1.3	0.5
15	"	4.4	1.0	0.9	1.0	0.5
21	"	4.2	1.0	1.0	1.0	0.6
		4.8	1.3	1.1	1.1	0.5

TABLE 53A. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: November 14, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	3	4	5	6	7	Avg
1	40 mph at 40 hp				1	9		5.9
2	Idle				8	2		5.2
3	40 mph at 40 hp				4	6		5.6
4	30 mph at 40 hp			1	6	3		5.2
5	20 mph at 40 hp				10			5.0
6	Idle-Acceleration				1	7	2	6.1
7	Deceleration			1	7	2		5.1
8	20 mph at 40 hp				6	4		5.4
9	30 mph at 40 hp				2	8		5.8
10	40 mph at 40 hp				1	8	1	6.0
11	Idle				4	5	1	5.7
12	30 mph at 40 hp				6	4		5.4
13	Deceleration			1	5	4		5.3
14	Idle-Acceleration				1	8	1	6.0
15	Deceleration		1	4	5			4.4
16	Idle-Acceleration			1	1	6	2	5.9
17	Idle				6	3	1	5.5
18	20 mph at 40 hp				3	7		5.7
19	30 mph at 40 hp			2	1	7		5.5
20	20 mph at 40 hp			1	6	3		5.2
21	Deceleration			8	2			4.2
22	Idle-Acceleration				1	4	5	6.4
23	40 mph at 40 hp					3	7	6.7
24	Idle					7	3	6.3

TABLE 53B. INTERIM VEHICLE ODOR EVALUATION RESULTS-ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: November 14, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"B" Burnt-Smoky Responses 1	2	3	Avg
1	40 mph at 40 hp	2	8		1.8
2	Idle	3	7		1.7
3	40 mph at 40 hp	1	9		1.9
4	30 mph at 40 hp	3	7		1.7
5	20 mph at 40 hp	8	2		1.2
6	Idle-Acceleration		10		2.0
7	Deceleration	4	6		1.6
8	20 mph at 40 hp	5	5		1.5
9	30 mph at 40 hp	1	9		1.9
10	40 mph at 40 hp	1	9		1.9
11	Idle	4	6		1.6
12	30 mph at 40 hp	4	6		1.6
13	Deceleration	5	5		1.5
14	Idle-Acceleration	1	8	1	2.0
15	Deceleration	10			1.0
16	Idle-Acceleration	3	7		1.7
17	Idle	1	9		1.9
18	20 mph at 40 hp	1	9		1.9
19	30 mph at 40 hp	4	6		1.6
20	20 mph at 40 hp	5	5		1.5
21	Deceleration	10			1.0
22	Idle-Acceleration		9	1	2.1
23	40 mph at 40 hp		9	1	2.1
24	Idle		9	1	2.1

TABLE 53C. INTERIM VEHICLE ODOR EVALUATION RESULTS-ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 676
Date: November 14, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Avg
1	40 mph at 40 hp		4	6	1.6
2	Idle		8	2	1.2
3	40 mph at 40 hp		3	7	1.7
4	30 mph at 40 hp		6	4	1.4
5	20 mph at 40 hp		8	2	1.2
6	Idle-Acceleration		4	6	1.6
7	Deceleration		9	1	1.1
8	20 mph at 40 hp		6	4	1.4
9	30 mph at 40 hp		5	5	1.5
10	40 mph at 40 hp		2	8	1.8
11	Idle		6	4	1.4
12	30 mph at 40 hp		6	4	1.4
13	Deceleration	1	7	2	1.2
14	Idle-Acceleration		5	5	1.5
15	Deceleration	1	9		0.9
16	Idle-Acceleration		5	5	1.5
17	Idle		8	2	1.2
18	20 mph at 40 hp		4	6	1.6
19	30 mph at 40 hp		5	5	1.5
20	20 mph at 40 hp		8	2	1.2
21	Deceleration		10		1.0
22	Idle-Acceleration		3	7	1.7
23	40 mph at 40 hp		2	8	1.8
24	Idle		5	5	1.5

TABLE 53D. INTERIM VEHICLE ODOR EVALUATION RESULTS-ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: November 14, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Avg
1	40 mph at 40 hp	1	9		0.9
2	Idle	1	8	1	1.0
3	40 mph at 40 hp	1	8	1	1.0
4	30 mph at 40 hp	1	9		0.9
5	20 mph at 40 hp		10		1.0
6	Idle-Acceleration	2	8		0.8
7	Deceleration		10		1.0
8	20 mph at 40 hp		10		1.0
9	30 mph at 40 hp	1	8	1	1.0
10	40 mph at 40 hp		10		1.0
11	Idle		5	5	1.5
12	30 mph at 40 hp		8	2	1.2
13	Deceleration		7	3	1.3
14	Idle-Acceleration	1	6	3	1.2
15	Deceleration		10		1.0
16	Idle-Acceleration		9	1	1.1
17	Idle		4	6	1.6
18	20 mph at 40 hp		8	2	1.2
19	30 mph at 40 hp		10		1.0
20	20 mph at 40 hp	1	7	2	1.1
21	Deceleration		10		1.0
22	Idle-Acceleration	1	6	3	1.2
23	40 mph at 40 hp		8	2	1.2
24	Idle	1	3	6	1.5

TABLE 53E. INTERIM VEHICLE ODOR EVALUATION RESULTS-ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: November 14, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Avg
1	40 mph at 40 hp	1	9		0.9
2	Idle	3	7		0.7
3	40 mph at 40 hp	3	7		0.7
4	30 mph at 40 hp	2	8		0.8
5	20 mph at 40 hp	1	9		0.9
6	Idle-Acceleration		9	1	1.1
7	Deceleration	5	5		0.5
8	20 mph at 40 hp	1	9		0.9
9	30 mph at 40 hp		10		1.0
10	40 mph at 40 hp	2	7	1	0.9
11	Idle	2	8		0.8
12	30 mph at 40 hp	1	9		0.9
13	Deceleration	5	5		0.5
14	Idle-Acceleration		9	1	1.1
15	Deceleration	5	5		0.5
16	Idle-Acceleration	1	7	2	1.1
17	Idle	2	8		0.8
18	20 mph at 40 hp	1	8	1	1.0
19	30 mph at 40 hp	1	9		0.9
20	20 mph at 40 hp		10		1.0
21	Deceleration	4	6		0.6
22	Idle-Acceleration		8	2	1.2
23	40 mph at 40 hp		6	4	1.4
24	Idle		9	1	1.1

TABLE 54. COMPUTATION OF "U" STATISTICS TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 676
Test Months: 3
Test Mileage: 10,610

Date: November 14 and 15, 1968
Operating Conditions: See Tables 2 through 5

Operating Condition	Relative Ranking	Odor Quality					Operating Condition	Relative Ranking	Odor Quality				
		"D"	"B"	"Q"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I 20 mph 40 hp	1	A(2)	A	A	A	A	IV Idle	1	S	S	S	A	A
	2	A	A	A	A	A		2	A	S	S	S	A
	3	A	A	A	S(4)	S(4)		3	S	S	S	S	A
	4	A	S	S	S(4)	A(4)		4	S	A	S	S	S
	5	S(1)	S	S	A(4)	S(4)		5	S	A(4)	A	S	S
	6	S	S	S	S(4)	A(4)		6	A	S(4)	A	A	S
	7	S	A	S	A	S		7	A	A	A	A	S
	8	S	S	A	S	S		8	A	A	A	A	A
	U_s(3)	0	3	4	4.5	2		U_s	3	1.5	0	4	4
II 30 mph 40 hp	1	A	S	S	S(4)	A	V Idle- Acceleration	1	A(4)	A	A	A	S
	2	A	A(4)	S	A(4)	A(4)		2	S(4)	S(4)	A	S	A
	3	S(4)	S(4)	A(4)	A	S(4)		3	A(4)	S(4)	A(4)	A	A
	4	S(4)	A(4)	S(4)	A	A(4)		4	S(4)	A(4)	S(4)	A(4)	A
	5	A(4)	S(4)	A(4)	S	S(4)		5	A	A(4)	A(4)	S(4)	A(4)
	6	S(4)	A(4)	A(4)	A(4)	A(4)		6	A	A	S(4)	A(4)	S(4)
	7	S(4)	S	S(4)	S(4)	S		7	S	S	S	S	S
	8	A	A	A(4)	S	S		8	S	S	S	S	S
	U_s	6	6.5	4	5	2.5		U_s	6	4	2	4	4.5
III 40 mph 40 hp	1	S	S	S	A	A	VI Deceleration	1	A	A	A	A(4)	A(4)
	2	A	S	S	S(4)	A(4)		2	A	A	S(4)	A(4)	A(4)
	3	S(4)	S	S	A(4)	S(4)		3	S	S	A(4)	S(4)	S(4)
	4	A(4)	A(4)	A(4)	S(4)	A(4)		4	S	S	S(4)	A(4)	A(4)
	5	S(4)	S(4)	S(4)	A(4)	S		5	S	S	S(4)	S	A
	6	A(4)	S	A	A	S		6	A	A	A(4)	S	S
	7	S(4)	S	A	S	S		7	A	S(4)	S(4)	A	S
	8	A	S	A	S	A		8	S	A(4)	A	S	S
	U_s	5.5	0.5	0.5	4	5		U_s	6	6.5	8	4.5	2.5

(1) "S" stands for EM-73-F untreated fuel.

(2) "A" stands for EM-73-F treated with odor additive.

(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.

(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 55. COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 676
Date: November 14 and 15, 1968
Operating Conditions: See Tables 21 and 22

Constant Speed Results (all open-rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
			Max	Min	Avg
A. Untreated	20	46	12	12	12.0
Treated	20	47	14	13	13.3
Net Change					+1.3
B. Untreated	25	58	10	9	9.7
Treated	25	58	11	11	11.0
Net Change					+1.3
C. Untreated	30	69	9	9	9.0
Treated	30	68	11	10	10.3
Net Change					+1.3
D. Untreated	35	78	9	8	8.3
Treated	35	78	10	10	10.0
Net Change					+1.7

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of engine			
Untreated	15	14	14.3
Treated	16	14	15.0
Net Change			+0.7
During acceleration			
Untreated	8	7	7.7
Treated	8	8	8.0
Net Change			+0.3
After upshift			
Untreated	8	7	7.7
Treated	9	8	8.7
Net Change			+1.0

TABLE 56. COMPARISON OF ODOR PANEL RESPONSES FOR TREATED FUEL VERSUS UNTREATED FUEL-INTERIM EVALUATION

Vehicle: Bus 678
Test Months: 3
Test Mileage: 7,531

Date: November 18 and 19, 1968
Operating Conditions: See Tables 2 through 5

Operating Condition	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Untreated	5.8	1.8	1.5	1.2	1.0
	Treated	5.7	1.8	1.5	1.2	1.0
	Net Change	-0.1	0	0	0	0
30 mph at 40 hp	Untreated	5.2	1.6	1.4	1.1	0.8
	Treated	5.5	1.7	1.3	1.1	1.0
	Net Change	+0.3	+0.1	-0.1	0	+0.2
40 mph at 40 hp	Untreated	5.8	2.0	1.5	1.2	1.2
	Treated	5.6	1.7	1.5	1.1	0.9
	Net Change	-0.2	-0.3	0	-0.1	-0.3
Idle	Untreated	5.8	1.9	1.6	1.2	1.0
	Treated	6.2	2.0	1.5	1.3	1.1
	Net Change	+0.4	+0.1	-0.1	+0.1	+0.1
Idle-Acceleration	Untreated	6.3	1.9	1.6	1.3	1.2
	Treated	6.0	1.9	1.6	1.2	1.2
	Net Change	-0.3	0	0	-0.1	0
Deceleration	Untreated	5.0	1.5	1.3	1.0	0.7
	Treated	5.4	1.7	1.4	1.2	0.9
	Net Change	+0.4	+0.2	+0.1	+0.2	+0.2

TABLE 57. INTERIM VEHICLE ODOR EVALUATION SUMMARY - UNTREATED FUEL

Vehicle: Bus 678
Date: November 19, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
6	20 mph at 40 hp	6.3	2.0	1.8	1.3	1.0
8	" "	5.4	1.5	1.3	1.1	0.8
12	" "	5.9	2.0	1.4	1.1	1.0
20	" "	5.6	1.7	1.5	1.1	1.0
		5.8	1.8	1.5	1.2	1.0
3	30 mph at 40 hp	4.4	1.2	1.0	1.0	0.6
7	" "	5.7	1.7	1.4	1.2	0.9
11	" "	5.5	1.7	1.6	1.0	0.8
14	" "	5.2	1.8	1.6	1.0	0.9
		5.2	1.6	1.4	1.1	0.8
2	40 mph at 40 hp	4.7	1.4	1.2	0.9	0.9
17	" "	6.7	2.5	1.6	1.2	1.0
19	" "	6.5	2.1	1.7	1.4	1.6
23	" "	5.4	1.9	1.5	1.2	1.3
		5.8	2.0	1.5	1.2	1.2
5	Idle	5.3	1.8	1.4	1.2	0.9
13	"	5.8	1.8	1.6	1.1	1.1
18	"	6.2	2.0	1.6	1.2	1.0
22	"	6.0	2.0	1.7	1.3	1.1
		5.8	1.9	1.6	1.2	1.0
4	Idle-Acceleration	6.0	2.0	1.4	1.2	1.0
10	" "	6.3	1.8	1.6	1.4	1.4
15	" "	6.3	1.8	1.6	1.1	1.2
24	" "	6.5	2.1	1.8	1.3	1.3
		6.3	1.9	1.6	1.3	1.2
1	Deceleration	4.4	1.0	0.8	1.0	0.6
9	"	4.4	1.4	1.6	0.9	0.7
16	"	5.3	1.8	1.4	1.1	0.8
21	"	5.9	1.7	1.4	1.1	0.8
		5.0	1.5	1.3	1.0	0.7

TABLE 57A. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 678
Date: November 19, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses 3	4	5	6	7	8	Avg
1	Deceleration	1	4	5				4.4
2	40 mph at 40 hp		3	7				4.7
4	30 mph at 40 hp		6	4				4.4
4	Idle-Acceleration				10			6.0
5	Idle			7	3			5.3
6	20 mph at 40 hp				7	3		6.3
7	30 mph at 40 hp		1	3	4	2		5.7
8	20 mph at 40 hp			6	4			5.4
9	Deceleration		6	4				4.4
10	Idle-Acceleration				7	3		6.3
11	30 mph at 40 hp			5	5			5.5
12	20 mph at 40 hp			2	7	1		5.9
13	Idle			4	4	2		5.8
14	30 mph at 40 hp		3	2	5			5.2
15	Idle-Acceleration			2	3	5		6.3
16	Deceleration		3	1	6			5.3
17	40 mph at 40 hp				5	3	2	6.7
18	Idle			2	4	4		6.2
19	40 mph at 40 hp				5	5		6.5
20	20 mph at 40 hp			5	4	1		5.6
21	Deceleration			3	5	2		5.9
22	Idle			2	6	2		6.0
23	40 mph at 40 hp			1	4	5		5.4
24	Idle-Acceleration				5	5		6.5

TABLE 57B. INTERIM VEHICLE ODOR EVALUATION RESULTS-UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: November 19, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 1	2	3	Avg
1	Deceleration	10			1.0
2	40 mph at 40 hp	6	4		1.4
3	30 mph at 40 hp	8	2		1.2
4	Idle-Acceleration		10		2.0
5	Idle	2	8		1.8
6	20 mph at 40 hp		10		2.0
7	30 mph at 40 hp	3	7		1.7
8	20 mph at 40 hp	5	5		1.5
9	Deceleration	6	4		1.4
10	Idle-Acceleration	2	8		1.8
11	30 mph at 40 hp	3	7		1.7
12	20 mph at 40 hp	1	8	1	2.0
13	Idle	2	8		1.8
14	30 mph at 40 hp	3	6	1	1.8
15	Idle-Acceleration	2	6	2	1.8
16	Deceleration	2	8		1.8
17	40 mph at 40 hp		5	5	2.5
18	Idle	1	8	1	2.0
19	40 mph at 40 hp		9	1	2.1
20	20 mph at 40 hp	3	7		1.7
21	Deceleration	3	7		1.7
22	Idle	1	8	1	2.0
23	40 mph at 40 hp	1	9		1.9
24	Idle-Acceleration		9	1	2.1

TABLE 57C. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 678
Date: November 19, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Avg
1	Deceleration	2	8			0.8
2	40 mph at 40 hp		8	2		1.2
3	30 mph at 40 hp		10			1.0
4	Idle-Acceleration		6	4		1.4
5	Idle		6	4		1.4
6	20 mph at 40 hp		2	8		1.8
7	30 mph at 40 hp		6	4		1.4
8	20 mph at 40 hp		7	3		1.3
9	Deceleration		4	6		1.6
10	Idle-Acceleration		4	6		1.6
11	30 mph at 40 hp		4	6		1.6
12	20 mph at 40 hp		6	4		1.4
13	Idle		4	6		1.6
14	30 mph at 40 hp		4	6		1.6
15	Idle-Acceleration		4	6		1.6
16	Deceleration		6	4		1.4
17	40 mph at 40 hp		4	6		1.6
18	Idle		4	6		1.6
19	40 mph at 40 hp		3	7		1.7
20	20 mph at 40 hp		5	5		1.5
21	Deceleration		6	4		1.4
22	Idle		3	7		1.7
23	40 mph at 40 hp		5	5		1.5
24	Idle Acceleration		3	6	1	1.8

TABLE 57D. INTERIM VEHICLE ODOR EVALUATION RESULTS-UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 678
Date: November 19, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Avg
1	Deceleration		10		1.0
2	40 mph at 40 hp	1	9		0.9
3	30 mph at 40 hp		10		1.0
4	Idle-Acceleration		8	2	1.2
5	Idle		8	2	1.2
6	20 mph at 40 hp		7	3	1.3
7	30 mph at 40 hp		8	2	1.2
8	20 mph at 40 hp		9	1	1.1
9	Deceleration	1	9		0.9
10	Idle-Acceleration		6	4	1.4
11	30 mph at 40 hp		10		1.0
12	20 mph at 40 hp		9	1	1.1
13	Idle		9	1	1.1
14	30 mph at 40 hp		10		1.0
15	Idle-Acceleration		9	1	1.1
16	Deceleration	1	7	2	1.1
17	40 mph at 40 hp	1	6	3	1.2
18	Idle		8	2	1.2
19	40 mph at 40 hp		6	4	1.4
20	20 mph at 40 hp	1	7	2	1.1
21	Deceleration		9	1	1.1
22	Idle		7	3	1.3
23	40 mph at 40 hp		8	2	1.2
24	Idle-Acceleration		7	3	1.3

TABLE 57E. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 678
Date: November 19, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	Deceleration	4	6		0.6
2	40 mph at 40 hp	1	9		0.9
3	30 mph at 40 hp	4	6		0.6
4	Idle-Acceleration		10		1.0
5	Idle	1	9		0.9
6	20 mph at 40 hp	1	8	1	1.0
7	30 mph at 40 hp	1	9		0.9
8	20 mph at 40 hp	2	8		0.8
9	Deceleration	3	7		0.7
10	Idle-Acceleration	1	4	5	1.4
11	30 mph at 40 hp	2	8		0.8
12	20 mph at 40 hp	1	8	1	1.0
13	Idle		9	1	1.1
14	30 mph at 40 hp	1	9		0.9
15	Idle-Acceleration		8	2	1.2
16	Deceleration	2	8		0.8
17	40 mph at 40 hp	1	8	1	1.0
18	Idle	1	8	1	1.0
19	40 mph at 40 hp		4	6	1.6
20	20 mph at 40 hp		10		1.0
21	Deceleration	2	8		0.8
22	Idle		9	1	1.1
23	40 mph at 40 hp		7	3	1.3
24	Idle-Acceleration		7	3	1.3

TABLE 58. INTERIM VEHICLE ODOR EVALUATION SUMMARY - ADDITIVE TREATED FUEL

Vehicle: Bus 678
Date: November 18, 1968

Operating Conditions: See Tables 2 through 5

		Average Panel Responses				
Run No.	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	4.7	1.3	1.2	1.0	1.0
8	" "	5.9	1.9	1.6	1.2	1.0
14	" "	6.2	1.9	1.6	1.4	1.0
22	" "	6.0	1.9	1.6	1.0	0.9
		5.7	1.8	1.5	1.2	1.0
3	30 mph at 40 hp	5.0	1.4	1.0	0.8	0.9
9	" "	5.6	1.7	1.4	1.1	1.1
12	" "	5.8	1.8	1.4	1.2	1.1
16	" "	5.7	1.8	1.3	1.3	1.0
		5.5	1.7	1.3	1.1	1.0
1	40 mph at 40 hp	5.1	1.4	1.1	0.9	0.8
7	" "	6.0	1.9	1.8	1.2	1.0
10	" "	5.5	1.8	1.7	1.0	0.9
24	" "	5.8	1.8	1.4	1.2	0.9
		5.6	1.7	1.5	1.1	0.9
4	Idle	6.0	1.9	1.6	1.3	0.9
11	"	6.5	1.9	1.6	1.3	1.4
18	"	6.1	2.0	1.6	1.2	1.1
23	"	6.0	2.1	1.4	1.3	1.1
		6.2	2.0	1.5	1.3	1.1
6	Idle-Acceleration	6.0	1.9	1.7	1.3	1.2
13	" "	6.5	2.0	1.7	1.1	1.2
17	" "	6.5	1.9	1.6	1.4	1.5
21	" "	5.0	1.7	1.2	1.1	0.9
		6.0	1.9	1.6	1.2	1.2
5	Deceleration	5.1	1.3	1.0	1.1	0.8
15	"	6.2	2.2	1.7	1.6	0.9
19	"	5.0	1.5	1.3	1.0	0.8
20	"	5.4	1.7	1.5	1.1	1.1
		5.4	1.7	1.4	1.2	0.9

TABLE 58A. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 678
Date: November 18, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"D" Diesel Composite Responses				
		4	5	6	7	Avg
1	40 mph at 40 hp	1	7	2		5.1
2	20 mph at 40 hp	5	3	2		4.7
3	30 mph at 40 hp	1	8	1		5.0
4	Idle			10		6.0
5	Deceleration	1	7	2		5.1
6	Idle-Acceleration			10		6.0
7	40 mph at 40 hp		1	8	1	6.0
8	20 mph at 40 hp		3	5	2	5.9
9	30 mph at 40 hp		5	4	1	5.6
10	40 mph at 40 hp		5	5		5.5
11	Idle			5	5	6.5
12	30 mph at 40 hp		3	6	1	5.8
13	Idle-Acceleration		1	3	6	6.5
14	20 mph at 40 hp			8	2	6.2
15	Deceleration		1	6	3	6.2
16	30 mph at 40 hp		4	5	1	5.7
17	Idle-Acceleration		2	1	7	6.5
18	Idle		1	7	2	6.1
19	Deceleration	1	8	1		5.0
20	Deceleration	1	4	5		5.4
21	Idle-Acceleration	1	5	3	1	5.0
22	20 mph at 40 hp			10		6.0
23	Idle		2	6	2	6.0
24	40 mph at 40 hp		2	8		5.8

TABLE 58B. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: November 18, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"B" Burnt-Smoky Responses			
		1	2	3	Avg
1	40 mph at 40 hp	6	4		1.4
2	20 mph at 40 hp	7	3		1.3
3	30 mph at 40 hp	6	4		1.4
4	Idle	1	9		1.9
5	Deceleration	7	3		1.3
6	Idle-Acceleration	1	9		1.9
7	40 mph at 40 hp	1	9		1.9
8	20 mph at 40 hp	1	9		1.9
9	30 mph at 40 hp	3	7		1.7
10	40 mph at 40 hp	2	8		1.8
11	Idle	1	9		1.9
12	30 mph at 40 hp	2	8		1.8
13	Idle-Acceleration	2	6	2	2.0
14	20 mph at 40 hp	1	9		1.9
15	Deceleration		8	2	2.2
16	30 mph at 40 hp	2	8		1.8
17	Idle-Acceleration	2	7	1	1.9
18	Idle	1	8	1	2.0
19	Deceleration	5	5		1.5
20	Deceleration	3	7		1.7
21	Idle-Acceleration	3	7		1.7
22	20 mph at 40 hp	2	7	1	1.9
23	Idle	1	7	2	2.1
24	40 mph at 40 hp	2	8		1.8

TABLE 58C. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 678
Date: November 18, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Avg
1	40 mph at 40 hp		9	1		1.1
2	20 mph at 40 hp		8	2		1.2
3	30 mph at 40 hp	1	8	1		1.0
4	Idle		4	6		1.6
5	Deceleration		10			1.0
6	Idle-Acceleration		3	7		1.7
7	40 mph at 40 hp		2	8		1.8
8	20 mph at 40 hp		4	6		1.6
9	30 mph at 40 hp		6	4		1.4
10	40 mph at 40 hp		3	7		1.7
11	Idle		4	6		1.6
12	30 mph at 40 hp		6	4		1.4
13	Idle-Acceleration		3	7		1.7
14	20 mph at 40 hp		4	6		1.6
15	Deceleration		4	5	1	1.7
16	30 mph at 40 hp		7	3		1.3
17	Idle-Acceleration		4	6		1.6
18	Idle		4	6		1.6
19	Deceleration		7	3		1.3
20	Deceleration		5	5		1.5
21	Idle-Acceleration	1	7	2		1.2
22	20 mph at 40 hp		4	6		1.6
23	Idle		6	4		1.4
24	40 mph at 40 hp		6	4		1.4

TABLE 58D. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 678
Date: November 18, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Avg
1	40 mph at 40 hp	1	9		0.9
2	20 mph at 40 hp		10		1.0
3	30 mph at 40 hp	2	8		0.8
4	Idle		7	3	1.3
5	Deceleration		9	1	1.1
6	Idle-Acceleration		7	3	1.3
7	40 mph at 40 hp	1	6	3	1.2
8	20 mph at 40 hp		8	2	1.2
9	30 mph at 40 hp		9	1	1.1
10	40 mph at 40 hp	1	8	1	1.0
11	Idle		7	3	1.3
12	30 mph at 40 hp		8	2	1.2
13	Idle-Acceleration		9	1	1.1
14	20 mph at 40 hp		6	4	1.4
15	Deceleration		4	6	1.6
16	30 mph at 40 hp	1	5	4	1.3
17	Idle-Acceleration		6	4	1.4
18	Idle		8	2	1.2
19	Deceleration	2	6	2	1.0
20	Deceleration	1	7	2	1.1
21	Idle-Acceleration		9	1	1.1
22	20 mph at 40 hp		10		1.0
23	Idle	1	5	4	1.3
24	40 mph at 40 hp	1	6	3	1.2

TABLE 58E. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 678
Date: November 18, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Avg
1	40 mph at 40 hp	2	8		0.8
2	20 mph at 40 hp		10		1.0
3	30 mph at 40 hp	1	9		0.9
4	Idle	1	9		0.9
5	Deceleration	2	8		0.8
6	Idle-Acceleration		8	2	1.2
7	40 mph at 40 hp		10		1.0
8	20 mph at 40 hp	1	8	1	1.0
9	30 mph at 40 hp		9	1	1.1
10	40 mph at 40 hp	1	9		0.9
11	Idle		6	4	1.4
12	30 mph at 40 hp		9	1	1.1
13	Idle-Acceleration		8	2	1.2
14	20 mph at 40 hp		10		1.0
15	Deceleration	2	7	1	0.9
16	30 mph at 40 hp	1	8	1	1.0
17	Idle-Acceleration		5	5	1.5
18	Idle		9	1	1.1
19	Deceleration	2	8		0.8
20	Deceleration		9	1	1.1
21	Idle-Acceleration	1	9		0.9
22	20 mph at 40 hp	1	9		0.9
23	Idle	1	7	2	1.1
24	40 mph at 40 hp	1	9		0.9

TABLE 59. COMPUTATION OF "U" STATISTICS TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 678
Test Months: 3
Test Mileage: 7,531

Date: November 18 and 19, 1968
Operating Conditions: See Tables 2 through 5

Operating Condition	Relative Ranking	Odor Quality					Operating Condition	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I 20 mph 40 hp	1	A	A	A	A	S	IV Idle	1	S	S	A(4)	S	S(4)
	2	S(1)	S	S	A	A		2	S	S	S(4)	S(4)	A(4)
	3	S	S	S	S	S(4)		3	A(4)	A	A(4)	A(4)	S
	4	A(4)	A	S	S	A(4)		4	S(4)	A	S(4)	S(4)	A(4)
	5	S(4)	A	A	S	S(4)		5	A(4)	S(4)	A(4)	A(4)	S(4)
	6	A(2)	A	A	A	A(4)		6	A	A(4)	S(4)	A(4)	A(4)
	7	A	S	A	S	S(4)		7	S	S(4)	A(4)	S(4)	S(4)
	8	S	S	S	A	A(4)		8	A	A	S	A(4)	A
	U_s(3)	7.5	6	7	7	7.5		U_s	4	5	6.5	3.5	5.5
II 30 mph 40 hp	1	S	S	A(4)	A	S	V Idle- Acceleration	1	A	A	A	A(4)	A
	2	A	A	S(4)	S	S		2	S(4)	S	S	S(4)	S
	3	S	S(4)	A	S	S(4)		3	A(4)	S	A(4)	A(4)	A(4)
	4	S	A(4)	A(4)	S	A(4)		4	S	A	S(4)	S	S(4)
	5	A	S(4)	S(4)	A	S(4)		5	S	A	A(4)	A(4)	A(4)
	6	A(4)	A(4)	A(4)	S(4)	A		6	A(4)	S(4)	A	S(4)	S
	7	S(4)	S(4)	S	A(4)	A		7	S(4)	A(4)	A	A(4)	S
	8	A	A(4)	S	A	A		8	A(4)	S	S	S(4)	A
	U_s	4.5	6	4.5	5.5	1		U_s	7.5	6.5	5	7	7
III 40 mph 40 hp	1	S	S(4)	A	S(4)	A	VI Deceleration	1	S	S	S	S	S
	2	A	A(4)	S	A(4)	A(4)		2	S	A	A	A(4)	S
	3	S	A	A	A	S(4)		3	A	S	A	S(4)	A(4)
	4	A	A	S	S(4)	A(4)		4	A	A	S	A(4)	S(4)
	5	A	S(4)	S	A(4)	S(4)		5	S	S(4)	S	S(4)	A(4)
	6	A	A(4)	A(4)	S(4)	A(4)		6	A	A(4)	A	A(4)	S(4)
	7	S	S	S(4)	A(4)	S		7	S	S	S	S(4)	A
	8	S	S	A	S	S		8	A	A	A	A	A
	U_s	7	4	7.5	5.5	2.5		U_s	5	6.5	7	4.5	2

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 60. COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 678
Date: November 18 and 19, 1968

Operating Conditions: See Tables 21 and 22

Constant Speed Results (all open-rack--maximum output)

Type Operation		Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
				Max	Min	Avg
A.	Untreated	20	43	15	14	14.3
	Treated		46	15	13	14.0
	Net Change					-0.3
B.	Untreated	25	60	11	10	10.3
	Treated		62	11	10	10.3
	Net Change					0
C.	Untreated	30	69	9	9	9.0
	Treated		71	11	10	10.3
	Net Change					+1.3
D.	Untreated	35	81	7.5	7	7.2
	Treated		78	10	9	9.3
	Net Change					+2.1

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of engine			
Untreated	9	8	8.3
Treated	10	9	9.3
Net Change			+1.0
During acceleration			
Untreated	8	6	6.7
Treated	7	6	6.3
Net Change			-0.4
After upshift			
Untreated	9	8	8.3
Treated	9	8	8.7
Net Change			+0.4

TABLE 61. COMPARISON OF ODOR PANEL RESPONSES FOR TREATED FUEL VERSUS UNTREATED FUEL-INTERIM EVALUATION

Vehicle: Bus 680
Test Months: 3
Test Mileage: 9678

Date: November 21 and 22, 1968
Operating Conditions: See Tables 5 through 5

Operating Condition	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Untreated	6.1	2.0	1.6	1.1	1.1
	Treated	6.1	1.9	1.5	1.3	1.1
	Net Change	0	-0.1	-0.1	+0.2	0
30 mph at 40 hp	Untreated	5.6	1.8	1.5	1.0	1.0
	Treated	5.8	1.8	1.5	1.1	1.0
	Net Change	+0.2	0	0	+0.1	0
40 mph at 40 hp	Untreated	5.7	1.7	1.6	1.1	0.9
	Treated	5.5	1.6	1.4	1.0	1.1
	Net Change	-0.2	-0.1	-0.2	-0.1	+0.2
Idle	Untreated	5.8	1.8	1.4	1.1	1.1
	Treated	6.2	1.9	1.6	1.4	1.2
	Net Change	+0.4	+0.1	+0.2	+0.3	+0.1
Idle-Acceleration	Untreated	6.5	2.1	1.7	1.2	1.1
	Treated	5.9	1.9	1.6	1.2	1.1
	Net Change	-0.6	-0.2	-0.1	0	0
Deceleration	Untreated	6.0	1.7	1.6	1.1	1.2
	Treated	5.8	1.8	1.6	1.1	1.1
	Net Change	-0.2	+0.1	0	0	-0.1

TABLE 62. INTERIM VEHICLE ODOR EVALUATION SUMMARY - UNTREATED FUEL

Vehicle: Bus 680
Date: November 22, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

		Average Panel Responses				
Run No.	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	6.4	2.1	1.6	1.0	1.3
7	" "	5.8	1.9	1.4	1.1	1.0
13	" "	6.0	1.9	1.6	1.1	0.9
18	" "	6.1	1.9	1.7	1.2	1.3
		6.1	2.0	1.6	1.1	1.1
5	30 mph at 40 hp	5.2	1.7	1.4	1.0	0.9
10	" "	5.8	1.8	1.5	1.1	1.1
15	" "	5.4	1.7	1.4	0.9	0.9
20	" "	6.0	1.8	1.8	1.0	1.1
		5.6	1.8	1.5	1.0	1.0
2	40 mph at 40 hp	5.4	1.6	1.5	1.1	0.8
11	" "	5.8	1.7	1.5	1.1	0.8
16	" "	5.7	1.8	1.5	1.0	0.9
22	" "	5.9	1.8	1.7	1.1	1.2
		5.7	1.7	1.6	1.1	0.9
6	Idle	5.5	1.8	1.4	1.3	1.0
8	"	5.5	1.7	1.1	1.2	0.9
19	"	6.3	2.0	1.6	0.9	1.3
24	"	5.8	1.7	1.5	1.0	1.1
		5.8	1.8	1.4	1.1	1.1
4	Idle-Acceleration	6.0	1.9	1.6	1.2	0.8
12	" "	7.0	2.2	1.8	1.2	1.4
17	" "	6.4	2.1	1.9	1.2	0.9
23	" "	6.5	2.1	1.7	1.1	1.3
		6.5	2.1	1.7	1.2	1.1
1	Deceleration	4.9	1.5	1.3	0.9	0.8
9	"	5.9	1.7	1.5	1.2	1.2
14	"	6.5	2.0	1.8	1.2	1.3
21	"	6.5	1.8	1.8	1.1	1.4
		6.0	1.7	1.6	1.1	1.2

TABLE 62A. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 680
Date: November 22, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses					
		4	5	6	7	8	Avg
1	Deceleration	2	7	1			4.9
2	40 mph at 40 hp	1	4	5			5.4
3	20 mph at 40 hp			6	4		6.4
4	Idle-Acceleration			10			6.0
5	30 mph at 40 hp	2	4	4			5.2
6	Idle	1	4	4	1		5.5
7	20 mph at 40 hp		2	8			5.8
8	Idle		5	5			5.5
9	Deceleration	1	2	4	3		5.9
10	30 mph at 40 hp		5	3	1	1	5.8
11	40 mph at 40 hp		2	8			5.8
12	Idle-Acceleration				10		7.0
13	20 mph at 40 hp		1	8	1		6.0
14	Deceleration			5	5		6.5
15	30 mph at 40 hp		6	4			5.4
16	40 mph at 40 hp		4	5	1		5.7
17	Idle-Acceleration			6	4		6.4
18	20 mph at 40 hp		3	3	4		6.1
19	Idle			7	3		6.3
20	30 mph at 40 hp		2	6	2		6.0
21	Deceleration		1	3	6		6.5
22	40 mph at 40 hp	1	2	4	3		5.9
23	Idle-Acceleration		2	1	7		6.5
24	Idle		2	8			5.8

TABLE 62B. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: November 22, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 1	2	3	Avg
1	Deceleration	5	5		1.5
2	40 mph at 40 hp	4	6		1.6
3	20 mph at 40 hp		9	1	2.1
4	Idle-Acceleration	1	9		1.9
5	30 mph at 40 hp	3	7		1.7
6	Idle	3	6	1	1.8
7	20 mph at 40 hp	1	9		1.9
8	Idle	3	7		1.7
9	Deceleration	3	7		1.7
10	30 mph at 40 hp	3	6	1	1.8
11	40 mph at 40 hp	3	7		1.7
12	Idle-Acceleration		8	2	2.2
13	20 mph at 40 hp	1	9		1.9
14	Deceleration		10		2.0
15	30 mph at 40 hp	3	7		1.7
16	40 mph at 40 hp	2	8		1.8
17	Idle-Acceleration		9	1	2.1
18	20 mph at 40 hp	2	7	1	1.9
19	Idle		10		2.0
20	30 mph at 40 hp	2	8		1.8
21	Deceleration	2	8		1.8
22	40 mph at 40 hp	3	6	1	1.8
23	Idle-Acceleration	1	7	2	2.1
24	Idle	3	7		1.7

TABLE 62C. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: November 22, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses				
		0	1	2	3	Avg
1	Deceleration		7	3		1.3
2	40 mph at 40 hp		5	5		1.5
3	20 mph at 40 hp		4	6		1.6
4	Idle-Acceleration		4	6		1.6
5	30 mph at 40 hp		6	4		1.4
6	Idle		6	4		1.4
7	20 mph at 40 hp		6	4		1.4
8	Idle		9	1		1.1
9	Deceleration		5	5		1.5
10	30 mph at 40 hp		5	5		1.5
11	40 mph at 40 hp		5	5		1.5
12	Idle-Acceleration		3	6	1	1.8
13	20 mph at 40 hp		4	6		1.6
14	Deceleration		2	8		1.8
15	30 mph at 40 hp		6	4		1.4
16	40 mph at 40 hp		5	5		1.5
17	Idle-Acceleration		1	9		1.9
18	20 mph at 40 hp		3	7		1.7
19	Idle		4	6		1.6
20	30 mph at 40 hp		2	8		1.8
21	Deceleration		3	6	1	1.8
22	40 mph at 40 hp		3	7		1.7
23	Idle-Acceleration		3	7		1.7
24	Idle		5	5		1.5

TABLE 62D. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 680
Date: November 22, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Avg
1	Deceleration	1	9		0.9
2	40 mph at 40 hp		9	1	1.1
3	20 mph at 40 hp	1	8	1	1.0
4	Idle-Acceleration		8	2	1.2
5	30 mph at 40 hp	2	6	2	1.0
6	Idle		7	3	1.3
7	20 mph at 40 hp		9	1	1.1
8	Idle		8	2	1.2
9	Deceleration		8	2	1.2
10	30 mph at 40 hp	1	7	2	1.1
11	40 mph at 40 hp		9	1	1.1
12	Idle-Acceleration	1	6	3	1.2
13	20 mph at 40 hp		9	1	1.1
14	Deceleration		8	2	1.2
15	30 mph at 40 hp	1	9		0.9
16	40 mph at 40 hp		10		1.0
17	Idle-Acceleration		8	2	1.2
18	20 mph at 40 hp		8	2	1.2
19	Idle	2	7	1	0.9
20	30 mph at 40 hp	1	8	1	1.0
21	Deceleration	1	7	2	1.1
22	40 mph at 40 hp		9	1	1.1
23	Idle-Acceleration		9	1	1.1
24	Idle		10		1.0

TABLE 62E. INTERIM VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 680
Date: November 22, 1968

Operating Conditions: See Tables 2 through 5
Fuel: EM-73-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Avg
1	Deceleration	2	8		0.8
2	40 mph at 40 hp	2	8		0.8
3	20 mph at 40 hp		7	3	1.3
4	Idle-Acceleration	2	8		0.8
5	30 mph at 40 hp	2	7	1	0.9
6	Idle	1	8	1	1.0
7	20 mph at 40 hp		10		1.0
8	Idle	1	9		0.9
9	Deceleration		8	2	1.2
10	30 mph at 40 hp		9	1	1.1
11	40 mph at 40 hp	2	8		0.8
12	Idle-Acceleration		6	4	1.4
13	20 mph at 40 hp	1	9		0.9
14	Deceleration		7	3	1.3
15	30 mph at 40 hp	1	9		0.9
16	40 mph at 40 hp	1	9		0.9
17	Idle-Acceleration	1	9		0.9
18	20 mph at 40 hp		7	3	1.3
19	Idle		7	3	1.3
20	30 mph at 40 hp	1	7	2	1.1
21	Deceleration		6	4	1.4
22	40 mph at 40 hp		8	2	1.2
23	Idle-Acceleration		7	3	1.3
24	Idle		9	1	1.1

TABLE 63. INTERIM VEHICLE ODOR EVALUATION SUMMARY - ADDITIVE TREATED FUEL

Vehicle: Bus 680
Date: November 21, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
5	20 mph at 40 hp	6.7	2.0	1.6	1.3	1.4
8	" "	6.6	2.1	1.8	1.3	1.3
18	" "	5.8	1.9	1.3	1.5	0.8
20	" "	5.4	1.5	1.3	1.0	1.0
		6.1	1.9	1.5	1.3	1.1
4	30 mph at 40 hp	5.8	1.8	1.6	1.1	0.9
9	" "	6.3	1.9	1.5	1.4	1.3
12	" "	5.4	1.7	1.3	1.0	1.0
19	" "	5.7	1.8	1.5	0.9	0.9
		5.8	1.8	1.5	1.1	1.0
1	40 mph at 40 hp	5.2	1.4	1.1	0.9	1.0
3	" "	5.8	1.6	1.5	1.1	1.2
10	" "	5.5	1.7	1.3	1.2	1.0
23	" "	5.6	1.7	1.5	0.9	1.0
		5.5	1.6	1.4	1.0	1.1
2	Idle	6.1	1.9	1.7	1.4	1.0
11	"	6.7	2.1	1.8	1.4	1.4
17	"	6.0	1.8	1.5	1.5	1.0
24	"	6.1	1.7	1.5	1.1	1.3
		6.2	1.9	1.6	1.4	1.2
6	Idle-Acceleration	6.0	1.9	1.7	1.3	1.2
14	" "	6.3	2.0	1.5	1.0	1.4
16	" "	5.6	1.8	1.6	1.2	0.9
22	" "	5.6	1.8	1.6	1.1	0.9
		5.9	1.9	1.6	1.2	1.1
7	Deceleration	6.3	2.1	1.7	1.3	1.3
13	"	5.7	1.8	1.5	1.1	1.0
15	"	5.6	1.6	1.5	1.1	0.9
21	"	5.7	1.7	1.5	1.0	1.0
		5.8	1.8	1.6	1.1	1.1

TABLE 63A. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 680
Date: November 21, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"D" Diesel Composite Responses					
		4	5	6	7	8	Avg
1	40 mph at 40 hp		8	2			5.2
2	Idle		1	7	2		6.1
3	40 mph at 40 hp		4	4	2		5.8
4	30 mph at 40 hp		2	8			5.8
5	20 mph at 40 hp			3	7		6.7
6	Idle-Acceleration		3	4	3		6.0
7	Deceleration		3	1	6		6.3
8	20 mph at 40 hp			4	6		6.6
9	30 mph at 40 hp		2	5	1	2	6.3
10	40 mph at 40 hp		5	5			5.5
11	Idle			3	7		6.7
12	30 mph at 40 hp		6	4			5.4
13	Deceleration		5	3	2		5.7
14	Idle-Acceleration		1	5	4		6.3
15	Deceleration		4	6			5.6
16	Idle-Acceleration	2		8			5.6
17	Idle		4	2	4		6.0
18	20 mph at 40 hp		3	6	1		5.8
19	30 mph at 40 hp		4	5	1		5.7
20	20 mph at 40 hp		6	4			5.4
21	Deceleration		3	7			5.7
22	Idle-Acceleration		4	6			5.6
23	40 mph at 40 hp	1	3	5	1		5.6
24	Idle		3	3	4		6.1

TABLE 63B. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: November 21, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"B" Burnt-Smoky Responses 1	2	3	Avg
1	40 mph at 40 hp	6	4		1.4
2	Idle	1	9		1.9
3	40 mph at 40 hp	4	6		1.6
4	30 mph at 40 hp	2	8		1.8
5	20 mph at 40 hp		10		2.0
6	Idle-Acceleration	1	9		1.9
7	Deceleration		9	1	2.1
8	20 mph at 40 hp		9	1	2.1
9	30 mph at 40 hp	3	5	2	1.9
10	40 mph at 40 hp	3	7		1.7
11	Idle		9	1	2.1
12	30 mph at 40 hp	3	7		1.7
13	Deceleration	3	6	1	1.8
14	Idle-Acceleration	1	8	1	2.0
15	Deceleration	4	6		1.6
16	Idle-Acceleration	2	8		1.8
17	Idle	3	6	1	1.8
18	20 mph at 40 hp	1	9		1.9
19	30 mph at 40 hp	2	8		1.8
20	20 mph at 40 hp	5	5		1.5
21	Deceleration	3	7		1.7
22	Idle-Acceleration	2	8		1.8
23	40 mph at 40 hp	3	7		1.7
24	Idle	4	5	1	1.7

TABLE 63C. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: November 21, 1968

Operating Conditions: See Tables 2 through 5

Run	Operating	"O" Oily Responses				
No.	Condition	0	1	2	3	Avg
1	40 mph at 40 hp		9	1		1.1
2	Idle		3	7		1.7
3	40 mph at 40 hp		5	5		1.5
4	30 mph at 40 hp		4	6		1.6
5	20 mph at 40 hp		4	6		1.6
6	Idle-Acceleration		3	7		1.7
7	Deceleration		3	7		1.7
8	20 mph at 40 hp		2	8		1.8
9	30 mph at 40 hp		5	5		1.5
10	40 mph at 40 hp		7	3		1.3
11	Idle		3	6	1	1.8
12	30 mph at 40 hp		7	3		1.3
13	Deceleration		5	5		1.5
14	Idle-Acceleration	1	3	6		1.5
15	Deceleration		5	5		1.5
16	Idle-Acceleration		4	6		1.6
17	Idle		6	3	1	1.5
18	20 mph at 40 hp		7	3		1.3
19	30 mph at 40 hp		5	5		1.5
20	20 mph at 40 hp		7	3		1.3
21	Deceleration		5	5		1.5
22	Idle-Acceleration		4	6		1.6
23	40 mph at 40 hp		5	5		1.5
24	Idle		5	5		1.5

TABLE 63D. INTERIM VEHICLE ODOR EVALUATION RESULTS-ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 680
Date: November 21, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Avg
1	40 mph at 40 hp	1	9		0.9
2	Idle		6	4	1.4
3	40 mph at 40 hp		9	1	1.1
4	30 mph at 40 hp		9	1	1.1
5	20 mph at 40 hp		7	3	1.3
6	Idle-Acceleration		7	3	1.3
7	Deceleration		7	3	1.3
8	20 mph at 40 hp		7	3	1.3
9	30 mph at 40 hp		6	4	1.4
10	40 mph at 40 hp		8	2	1.2
11	Idle		6	4	1.4
12	30 mph at 40 hp	1	8	1	1.0
13	Deceleration		9	1	1.1
14	Idle-Acceleration		10		1.0
15	Deceleration		9	1	1.1
16	Idle-Acceleration		8	2	1.2
17	Idle		5	5	1.5
18	20 mph at 40 hp		5	5	1.5
19	30 mph at 40 hp	1	9		0.9
20	20 mph at 40 hp	1	8	1	1.0
21	Deceleration		10		1.0
22	Idle-Acceleration		9	1	1.1
23	40 mph at 40 hp	1	7		0.9
24	Idle	1	7	2	1.1

TABLE 63E. INTERIM VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 680
Date: November 21, 1968

Operating Conditions: See Tables 2 through 5

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Avg
1	40 mph at 40 hp		10		1.0
2	Idle		10		1.0
3	40 mph at 40 hp		8	2	1.2
4	30 mph at 40 hp	2	7	1	0.9
5	20 mph at 40 hp		6	4	1.4
6	Idle-Acceleration		8	2	1.2
7	Deceleration		7	3	1.3
8	20 mph at 40 hp		7	3	1.3
9	30 mph at 40 hp		7	3	1.3
10	40 mph at 40 hp		10		1.0
11	Idle		6	4	1.4
12	30 mph at 40 hp		10		1.0
13	Deceleration	1	8	1	1.0
14	Idle-Acceleration		6	4	1.4
15	Deceleration	1	9		0.9
16	Idle-Acceleration	1	9		0.9
17	Idle	2	6	2	1.0
18	20 mph at 40 hp	2	8		0.8
19	30 mph at 40 hp	1	9		0.9
20	20 mph at 40 hp		10		1.0
21	Deceleration		10		1.0
22	Idle-Acceleration	1	9		0.9
23	40 mph at 40 hp		10		1.0
24	Idle		7	3	1.3

TABLE 64 COMPUTATION OF "U" STATISTIC TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 680
Test Months: 3
Test Mileage: 9678

Date: November 21 and 22, 1968
Operating Conditions: See Tables 2 through 5

Operating Condition	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"
I 20 mph 40 hp	1	A	A	A	$S^{(4)}$	A
	2	$S^{(4)}$	$S^{(4)}$	A	$A^{(4)}$	S
	3	$A^{(4)}$	$S^{(4)}$	S	S	$A^{(4)}$
	4	$S^{(1)}$	$A^{(4)}$	$S^{(4)}$	S	$S^{(4)}$
	5	S	$S^{(4)}$	$A^{(4)}$	S	$S^{(4)}$
	6	S	A	$S^{(4)}$	A	$A^{(4)}$
	7	$A^{(2)}$	$S^{(4)}$	S	A	$S^{(4)}$
	8	A	$A^{(4)}$	A	A	A
	$U_s^{(3)}$	7.5	8	6	3.5	7.5
II 30 mph 40 hp	1	S	$S^{(4)}$	A	$A^{(4)}$	$S^{(4)}$
	2	$A^{(4)}$	$A^{(4)}$	S	$S^{(4)}$	$A^{(4)}$
	3	$S^{(4)}$	$S^{(4)}$	S	$S^{(4)}$	$S^{(4)}$
	4	A	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$
	5	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$	A
	6	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$	S
	7	S	$A^{(4)}$	A	$A^{(4)}$	S
	8	A	A	S	A	A
	U_s	6	5	8	6	8
III 40 mph 40 hp	1	A	A	A	A	S
	2	S	$S^{(4)}$	A	A	S
	3	A	$A^{(4)}$	$S^{(4)}$	S	S
	4	A	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	A
	5	S	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	A
	6	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	A
	7	$S^{(4)}$	S	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$
	8	S	S	S	A	$A^{(4)}$
	U_s	4.5	3.5	3	6.5	3.5
IV Idle	1	S	$S^{(4)}$	S	S	S
	2	S	$A^{(4)}$	S	S	$A^{(4)}$
	3	S	$S^{(4)}$	$A^{(4)}$	A	$S^{(4)}$
	4	A	$S^{(4)}$	$S^{(4)}$	S	$A^{(4)}$
	5	A	$A^{(4)}$	$A^{(4)}$	S	S
	6	A	A	S	A	A
	7	S	S	A	A	$S^{(4)}$
	8	A	A	A	A	$A^{(4)}$
	U_s	3	5.5	3	2	6.5
V Idle- Acceleration	1	A	A	A	A	S
	2	A	A	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$
	3	$S^{(4)}$	$S^{(4)}$	$S^{(4)}$	$A^{(4)}$	$S^{(4)}$
	4	$A^{(4)}$	$A^{(4)}$	$A^{(4)}$	$S^{(4)}$	$A^{(4)}$
	5	A	A	$S^{(4)}$	$S^{(4)}$	A
	6	S	S	$A^{(4)}$	$A^{(4)}$	S
	7	S	S	S	$S^{(4)}$	$A^{(4)}$
	8	S	S	S	A	$S^{(4)}$
	U_s	1.5	1.5	2.5	7	7.5
VI Deceleration	1	S	S	S	S	S
	2	A	A	$A^{(4)}$	A	A
	3	A	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$	A
	4	A	$A^{(4)}$	$S^{(4)}$	$S^{(4)}$	A
	5	S	$S^{(4)}$	$A^{(4)}$	$A^{(4)}$	S
	6	A	$A^{(4)}$	A	S	$A^{(4)}$
	7	S	S	S	S	$S^{(4)}$
	8	S	A	S	A	S
	U_s	5	7	6.5	8	5.5

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of the relative rankings is used to compute (T).

TABLE 65. INTERIM COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 680
Date: November 21 and 22, 1968

Operating Conditions: See Tables 21 and 22

Constant Speed Results (all open-rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity		
			Max	Min	Avg
A. Untreated	20	42	11	9	10.0
Treated		43	12	11	11.3
Net Change					+1.3
B. Untreated	25	60	7	7	7.0
Treated		60	9	8	8.7
Net Change					+1.7
C. Untreated	30	68	7	6	6.3
Treated		71	9	8	8.3
Net Change					+2.0
D. Untreated	35	70	6	5	5.7
Treated		76	8	7	7.3
Net Change					+1.6

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of engine			
Untreated	7	6	6.3
Treated	7	6	6.7
Net Change			+0.4
During acceleration			
Untreated	4	3	3.3
Treated	4	3	3.3
Net Change			0
After upshift			
Untreated	6	4	5.0
Treated	5	5	5.0
Net Change			0

TABLE 66. COMPARISON OF ODOR PANEL RESPONSES FOR TREATED FUEL VERSUS UNTREATED FUEL - FINAL EVALUATION

Vehicle: Bus 676
Date: February 20 and 21, 1969

Operating Conditions: See Tables 2 through 5

Operating Conditions	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Untreated	5.6	1.4	1.3	1.1	1.0
	Treated	5.4	1.6	1.3	0.9	1.3
	Net Change	-0.2	+0.2	0	-0.2	+0.3
30 mph at 40 hp	Untreated	5.6	1.5	1.4	1.1	1.0
	Treated	5.5	1.6	1.4	1.0	1.4
	Net Change	-0.1	+0.1	0	-0.1	+0.4
40 mph at 40 hp	Untreated	6.0	1.9	1.5	1.2	1.0
	Treated	5.7	1.8	1.5	1.1	1.5
	Net Change	-0.3	-0.1	0	-0.1	+0.5
Idle	Untreated	6.0	1.8	1.6	1.2	1.0
	Treated	5.7	1.8	1.5	1.1	1.5
	Net Change	-0.3	0	-0.1	-0.1	+0.5
Idle-Acceleration	Untreated	6.1	1.9	1.8	1.1	1.1
	Treated	6.8	2.1	1.7	1.2	1.7
	Net Change	+0.7	+0.2	-0.1	+0.1	+0.6
Deceleration	Untreated	5.0	1.4	1.2	1.1	0.9
	Treated	5.1	1.5	1.1	1.1	1.1
	Net Change	+0.1	+0.1	-0.1	0	+0.2

TABLE 67. VEHICLE ODOR EVALUATION SUMMARY UNTREATED BASE FUEL

Vehicle: Bus 676
Date: February 21, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	20 mph at 40 hp	5.8	1.8	1.4	1.2	0.9
8	" "	5.2	1.2	1.1	1.1	1.0
12	" "	6.0	1.1	1.4	1.0	1.0
14	" "	5.4	1.6	1.3	1.0	1.0
		5.6	1.4	1.3	1.1	1.0
2	30 mph at 40 hp	5.0	1.3	1.1	1.0	1.0
5	" "	5.2	1.3	1.1	1.0	1.0
11	" "	5.8	1.7	1.6	1.1	1.0
13	" "	6.3	1.8	1.6	1.1	1.0
		5.6	1.5	1.4	1.1	1.0
1	40 mph at 40 hp	6.1	2.0	1.6	1.2	1.0
7	" "	5.7	1.7	1.2	1.1	0.9
9	" "	6.1	2.0	1.6	1.1	1.0
16	" "	6.0	1.8	1.7	1.2	1.0
		6.0	1.9	1.5	1.2	1.0
3	Idle	5.9	1.8	1.2	1.3	1.0
6	"	6.1	1.7	1.6	1.2	1.0
10	"	5.9	1.8	1.8	1.1	1.0
15	"	6.1	2.0	1.7	1.2	1.1
		6.0	1.8	1.6	1.2	1.0
19	Idle-Acceleration	6.0	1.9	1.8	1.1	1.1
21	" "	6.0	1.9	1.9	1.0	1.0
22	" "	6.3	2.0	1.7	1.1	1.2
24	" "	6.0	1.8	1.8	1.2	1.2
		6.1	1.9	1.8	1.1	1.1
17	Deceleration	4.9	1.3	1.0	1.0	0.8
18	"	5.0	1.4	1.2	1.2	0.9
20	"	5.1	1.4	1.2	1.2	1.0
23	"	5.1	1.6	1.2	1.0	0.8
		5.0	1.4	1.2	1.1	0.9

TABLE 67A. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: February 21, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"D" Diesel Composite Responses					
		4	5	6	6 1/2	7	Avg
1	40 mph at 40 hp		1	7		2	6.1
2	30 mph at 40 hp		10				5.0
3	Idle		3	5		2	5.9
4	20 mph at 40 hp		2	8			5.8
5	30 mph at 40 hp		8	2			5.2
6	Idle		2	4	2	2	6.1
7	40 mph at 40 hp		3	7			5.7
8	20 mph at 40 hp	1	6	3			5.2
9	40 mph at 40 hp			9		1	6.1
10	Idle		1	9			5.9
11	30 mph at 40 hp		2	8			5.8
12	20 mph at 40 hp		1	8		1	6.0
13	30 mph at 40 hp			7		3	6.3
14	20 mph at 40 hp		6	4			5.4
15	Idle			9		1	6.1
16	40 mph at 40 hp			10			6.0
17	Deceleration	1	9				4.9
18	Deceleration	2	6	2			5.0
19	Idle-Acceleration		1	8		1	6.0
20	Deceleration		9	1			5.1
21	Idle-Acceleration			10			6.0
22	Idle-Acceleration			7	1	2	6.3
23	Deceleration	1	7	2			5.1
24	Idle-Acceleration		1	8		1	6.0

TABLE 67B. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: February 21, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	Avg
1	40 mph at 40 hp		10	2.0
2	30 mph at 40 hp	7	3	1.3
3	Idle	2	8	1.8
4	20 mph at 40 hp	2	8	1.8
5	30 mph at 40 hp	7	3	1.3
6	Idle	3	7	1.7
7	40 mph at 40 hp	3	7	1.7
8	20 mph at 40 hp	8	2	1.2
9	40 mph at 40 hp		10	2.0
10	Idle	2	8	1.8
11	30 mph at 40 hp	3	7	1.7
12	20 mph at 40 hp	9	1	1.1
13	30 mph at 40 hp	2	8	1.8
14	20 mph at 40 hp	4	6	1.6
15	Idle		10	2.0
16	40 mph at 40 hp	2	8	1.8
17	Deceleration	7	3	1.3
18	Deceleration	6	4	1.4
19	Idle-Acceleration	1	9	1.9
20	Deceleration	6	4	1.4
21	Idle-Acceleration	1	9	1.9
22	Idle-Acceleration		10	2.0
23	Deceleration	4	6	1.6
24	Idle-Acceleration	2	8	1.8

TABLE 67C. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL
("O" Oily Standard)

Vehicle: Bus 676
Date: February 21, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"O" Oily Responses 1	2	Avg
1	40 mph at 40 hp	4	6	1.6
2	30 mph at 40 hp	9	1	1.1
3	Idle	8	2	1.2
4	20 mph at 40 hp	6	4	1.4
5	30 mph at 40 hp	9	1	1.1
6	Idle	4	6	1.6
7	40 mph at 40 hp	8	2	1.2
8	20 mph at 40 hp	9	1	1.1
9	40 mph at 40 hp	4	6	1.6
10	Idle	2	8	1.8
11	30 mph at 40 hp	4	6	1.6
12	20 mph at 40 hp	6	4	1.4
13	30 mph at 40 hp	4	6	1.6
14	20 mph at 40 hp	7	3	1.3
15	Idle	3	7	1.7
16	40 mph at 40 hp	3	7	1.7
17	Deceleration	10		1.0
18	Deceleration	8	2	1.2
19	Idle-Acceleration	2	8	1.8
20	Deceleration	8	2	1.2
21	Idle-Acceleration	1	9	1.9
22	Idle-Acceleration	3	7	1.7
23	Deceleration	8	2	1.2
24	Idle-Acceleration	2	8	1.8

TABLE 67D. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: February 21, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Avg
1	40 mph at 40 hp		8	2	1.2
2	30 mph at 40 hp	1	8	1	1.0
3	Idle		7	3	1.3
4	20 mph at 40 hp		8	2	1.2
5	30 mph at 40 hp		10		1.0
6	Idle		8	2	1.2
7	40 mph at 40 hp		9	1	1.1
8	20 mph at 40 hp		9	1	1.1
9	40 mph at 40 hp		9	1	1.1
10	Idle	1	7	2	1.1
11	30 mph at 40 hp		9	1	1.1
12	20 mph at 40 hp		10		1.0
13	30 mph at 40 hp		9	1	1.1
14	20 mph at 40 hp		10		1.0
15	Idle		8	2	1.2
16	40 mph at 40 hp		8	2	1.2
17	Deceleration		10		1.0
18	Deceleration		8	2	1.2
19	Idle-Acceleration		9	1	1.1
20	Deceleration		8	2	1.2
21	Idle-Acceleration	1	8	1	1.0
22	Idle-Acceleration		9	1	1.1
23	Deceleration		10		1.0
24	Idle-Acceleration		8	2	1.2

TABLE 67E. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: February 21, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	40 mph at 40 hp		10		1.0
2	30 mph at 40 hp		10		1.0
3	Idle		10		1.0
4	20 mph at 40 hp	1	9		0.9
5	30 mph at 40 hp		10		1.0
6	Idle		10		1.0
7	40 mph at 40 hp	1	9		0.9
8	20 mph at 40 hp		10		1.0
9	40 mph at 40 hp		10		1.0
10	Idle		10		1.0
11	30 mph at 40 hp		10		1.0
12	20 mph at 40 hp		10		1.0
13	30 mph at 40 hp		10		1.0
14	20 mph at 40 hp		10		1.0
15	Idle		9	1	1.1
16	40 mph at 40 hp		10		1.0
17	Deceleration	2	8		0.8
18	Deceleration	1	9		0.9
19	Idle-Acceleration		9	1	1.1
20	Deceleration		10		1.0
21	Idle-Acceleration		10		1.0
22	Idle-Acceleration		8	2	1.2
23	Deceleration	2	8		0.8
24	Idle-Acceleration		8	2	1.2

TABLE 68. VEHICLE ODOR EVALUATION SUMMARY ADDITIVE TREATED FUEL

Vehicle: Bus 676
Date: February 20, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	5.7	1.8	1.2	0.8	1.2
5	" "	5.9	1.7	1.4	0.9	1.4
10	" "	4.8	1.3	1.2	0.9	1.2
15	" "	5.3	1.4	1.3	0.9	1.3
		5.4	1.6	1.3	0.9	1.3
1	30 mph at 40 hp	5.8	1.3	1.6	0.9	1.6
6	" "	5.9	1.9	1.6	0.9	1.6
11	" "	5.0	1.4	1.1	1.0	1.1
14	" "	5.2	1.6	1.2	1.0	1.2
		5.5	1.6	1.4	1.0	1.4
2	40 mph at 40 hp	5.4	1.7	1.4	0.9	1.4
7	" "	5.6	1.8	1.7	1.3	1.7
9	" "	5.9	1.8	1.8	1.2	1.8
13	" "	5.8	1.9	1.2	1.1	1.2
		5.7	1.8	1.5	1.1	1.5
4	Idle	5.8	1.9	1.4	1.1	1.4
8	"	5.8	1.8	1.6	1.2	1.6
12	"	6.0	1.8	1.6	1.2	1.6
16	"	5.1	1.6	1.2	0.9	1.2
		5.7	1.8	1.5	1.1	1.5
17	Idle-Acceleration	6.9	2.1	1.6	1.1	1.6
20	" "	6.7	2.0	1.8	1.1	1.8
22	" "	6.7	2.1	1.8	1.2	1.8
23	" "	7.0	2.2	1.7	1.3	1.7
		6.8	2.1	1.7	1.2	1.7
18	Deceleration	5.0	1.4	1.0	1.2	1.0
19	"	4.6	1.4	0.8	1.0	0.8
21	"	5.2	1.6	1.2	1.1	1.2
24	"	5.6	1.6	1.3	1.0	1.3
		5.1	1.5	1.1	1.1	1.1

TABLE 68A. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: February 20, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"D" Diesel Composite Responses 3	4	5	6	7	Avg
1	30 mph at 40 hp			2	8		5.8
2	40 mph at 40 hp			6	4		5.4
3	20 mph at 40 hp			3	7		5.7
4	Idle			2	8		5.8
5	20 mph at 40 hp			1	9		5.9
6	30 mph at 40 hp			1	9		5.9
7	40 mph at 40 hp			4	6		5.6
8	Idle			2	8		5.8
9	40 mph at 40 hp			1	9		5.9
10	20 mph at 40 hp		2	8			4.8
11	30 mph at 40 hp		1	8	1		5.0
12	Idle			1	8	1	6.0
13	40 mph at 40 hp			2	8		5.8
14	30 mph at 40 hp			8	2		5.2
15	20 mph at 40 hp		2	3	5		5.3
16	Idle		1	7	2		5.1
17	Idle-Acceleration				1	9	6.9
18	Deceleration		1	8	1		5.0
19	Deceleration	1	2	7			4.6
20	Idle-Acceleration				3	7	6.7
21	Deceleration			8	2		5.2
22	Idle-Acceleration				3	7	6.7
23	Idle-Acceleration				1	10	7.0
24	Deceleration			4	6		5.6

TABLE 68B. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: February 20, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	30 mph at 40 hp	7	3		1.3
2	40 mph at 40 hp	3	7		1.7
3	20 mph at 40 hp	2	8		1.8
4	Idle	1	9		1.9
5	20 mph at 40 hp	3	7		1.7
6	30 mph at 40 hp	1	9		1.9
7	40 mph at 40 hp	2	8		1.8
8	Idle	2	8		1.8
9	40 mph at 40 hp	2	8		1.8
10	20 mph at 40 hp	7	3		1.3
11	30 mph at 40 hp	6	4		1.4
12	Idle	2	8		1.8
13	40 mph at 40 hp	1	9		1.9
14	30 mph at 40 hp	4	6		1.6
15	20 mph at 40 hp	6	4		1.4
16	Idle	4	6		1.6
17	Idle-Acceleration		9	1	2.1
18	Deceleration	6	4		1.4
19	Deceleration	6	4		1.4
20	Idle-Acceleration	1	8	1	2.0
21	Deceleration	4	6		1.6
22	Idle-Acceleration	1	7	2	2.1
23	Idle-Acceleration	1	6	3	2.2
24	Deceleration	4	6		1.6

TABLE 68C. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 676
Date: February 20, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"O" Oily Responses 0	1	2	3	Avg
1	30 mph at 40 hp		4	6		1.6
2	40 mph at 40 hp		6	4		1.4
3	20 mph at 40 hp		8	2		1.2
4	Idle		6	4		1.4
5	20 mph at 40 hp		6	4		1.4
6	30 mph at 40 hp		4	6		1.6
7	40 mph at 40 hp		3	7		1.7
8	Idle		4	6		1.6
9	40 mph at 40 hp		2	8		1.8
10	20 mph at 40 hp		8	2		1.2
11	30 mph at 40 hp		9	1		1.1
12	Idle		4	6		1.6
13	40 mph at 40 hp		8	2		1.2
14	30 mph at 40 hp		8	2		1.2
15	20 mph at 40 hp		7	3		1.3
16	Idle		8	2		1.2
17	Idle-Acceleration		4	6		1.6
18	Deceleration		10			1.0
19	Deceleration	2	8			0.8
20	Idle-Acceleration		3	6	1	1.8
21	Deceleration		8	2		1.2
22	Idle-Acceleration		3	6	1	1.8
23	Idle-Acceleration		4	5	1	1.7
24	Deceleration		7	3		1.3

TABLE 68D. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: February 20, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	30 mph at 40 hp	1	9		0.9
2	40 mph at 40 hp	1	9		0.9
3	20 mph at 40 hp	2	8		0.8
4	Idle	1	7	2	1.1
5	20 mph at 40 hp	1	9		0.9
6	30 mph at 40 hp	1	9		0.9
7	40 mph at 40 hp		7	3	1.3
8	Idle		8	2	1.2
9	40 mph at 40 hp		8	2	1.2
10	20 mph at 40 hp	1	9		0.9
11	30 mph at 40 hp	1	8	1	1.0
12	Idle		8	2	1.2
13	40 mph at 40 hp		9	1	1.1
14	30 mph at 40 hp		10		1.0
15	20 mph at 40 hp	1	9		0.9
16	Idle	1	9		0.9
17	Idle-Acceleration		9	1	1.1
18	Deceleration		8	2	1.2
19	Deceleration	1	8	1	1.0
20	Idle-Acceleration		9	1	1.1
21	Deceleration		9	1	1.1
22	Idle-Acceleration	1	6	3	1.2
23	Idle-Acceleration		7	3	1.3
24	Deceleration		10		1.0

TABLE 68E. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: February 20, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"P" Pungent Responses			
		0	1	2	Avg
1	30 mph at 40 hp	4	6		0.6
2	40 mph at 40 hp	4	6		0.6
3	20 mph at 40 hp	1	9		0.9
4	Idle	1	9		0.9
5	20 mph at 40 hp	1	9		0.9
6	30 mph at 40 hp	1	9		0.9
7	40 mph at 40 hp	2	7	1	0.9
8	Idle	2	8		0.8
9	40 mph at 40 hp		9	1	1.1
10	20 mph at 40 hp	3	7		0.7
11	30 mph at 40 hp	3	7		0.7
12	Idle		9	1	1.1
13	40 mph at 40 hp		10		1.0
14	30 mph at 40 hp	1	9		0.9
15	20 mph at 40 hp	3	7		0.7
16	Idle	3	7		0.7
17	Idle-Acceleration		8	2	1.2
18	Deceleration	3	7		0.7
19	Deceleration	2	8		0.8
20	Idle-Acceleration		8	2	1.2
21	Deceleration	1	9		0.9
22	Idle-Acceleration		7	3	1.3
23	Idle-Acceleration		7	3	1.3
24	Deceleration		10		1.0

TABLE 69. COMPUTATION OF "U" STATISTIC TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 676
Test Months: 6
Test Mileage: 19,220

Date: February 20 and 21, 1969
Operating Conditions: See Tables 2 through 5

Operating Conditions	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"	Operating Conditions	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
I	1	A	S	S	A	S	IV	1	A	A	A(4)	A	S
20 mph	2	S	S	A	A	S	Idle	2	A	S	S(4)	S(4)	S
40 hp	3	A	A	A	A	S		3	A	A(4)	A	A(4)	S
	4	S	A	S(4)	A	S		4	S	S(4)	A(4)	S(4)	S
	5	A	S	A(4)	S	A		5	S	A(4)	S(4)	A(4)	A
	6	S	A	S(4)	S	A		6	A	S(4)	A(4)	S(4)	A
	7	A	S(4)	A(4)	S	A		7	S	A	S	A(4)	A
	8	S	A(4)	S(4)	S	A		8	S	S	S	S	A
	U_s	6	5.5	6.5	0	0		U_s	2	7	4.5	4.5	0
II	1	S(4)	S(4)	S(4)	A	S	V	1	S	S	A	S	S
30 mph	2	A(4)	A(4)	A(4)	A	S	Idle-	2	S	S	S(4)	A(4)	S
40 hp	3	S(4)	S(4)	S(4)	S(4)	S	Acceleration	3	S	S	A(4)	S(4)	S
	4	A(4)	A	A	A(4)	S		4	S	S(4)	S(4)	A(4)	S
	5	S(4)	A	S(4)	S(4)	A		5	A	A(4)	A(4)	S(4)	A
	6	A(4)	S	A(4)	A(4)	A		6	A	A	S(4)	A(4)	A
	7	A	S	S(4)	S	A		7	A	A	A(4)	S(4)	A
	8	S	A	A(4)	S	A		8	A	A	S	A	A
	U_s	7.5	7	7	2	0		U_s	0	0.5	4.5	4.5	0
III	1	A	S(4)	S(4)	A	S	VI	1	A	S	A	A(4)	S(4)
40 mph	2	A	A(4)	A(4)	S(4)	S	Deceleration	2	S	A(4)	S(4)	S(4)	A(4)
40 hp	3	S	A(4)	A	A(4)	S		3	A(4)	S(4)	A(4)	A(4)	S(4)
	4	A	S(4)	S	S(4)	S		4	S(4)	A(4)	S(4)	S(4)	S
	5	A	A(4)	S	S(4)	A		5	S	S(4)	S(4)	A	A(4)
	6	S	A	A(4)	A(4)	A		6	S	A(4)	A(4)	S(4)	S(4)
	7	S	S	S(4)	S(4)	A		7	A	S(4)	S(4)	A(4)	A
	8	S	S	A	A	A		8	A	A(4)	A	S(4)	A
	U_s	2	5.5	7	8	0		U_s	7.5	5	7	6	3.5

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated fuel with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of the relative rankings is used to compute (T).

TABLE 70. COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 676
Date: February 21 and 24, 1969

Operating Conditions: See Tables 21 and 22

Constant Speed Results (All open rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity Max	Min	Avg
A. Untreated	20	47	8	8	8.0
Treated	20	46	10	10	10.0
Net Change					+2.0
B. Untreated	25	61	6	6	6.0
Treated	25	65	9	9	9.0
Net Change					+3.0
C. Untreated	30	73	6	6	6.0
Treated	30	73	9	7	8.0
Net Change					+2.0
D. Untreated	35	86	6	5	5.3
Treated	35	88	8	7	7.3
Net Change					+2.0

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity Max	Min	Avg
Start of engine			
Untreated	15	14	14.3
Treated	14	12	13.3
Net Change			-1.0
During acceleration			
Untreated	6	6	6.0
Treated	8	6	7.0
Net Change			+1.0
After upshift			
Untreated	6	5	5.3
Treated	6	5	5.7
Net Change			+0.4

TABLE 71. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 676
Date: February 20 and 21, 1969

Operating Conditions: See Table 23
Base Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes*, ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		SO_2, ppm		Adjusting Factor	
	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	470	400	4.4	4.3	1926	2,227	3.47	2.73	13.20	23.79	8.00	8.66	935.55	1027.95	1020	1020	0.13	0.05		
20 mph	510	400	4.4	4.7	1995	2,204	2.84	3.00	21.20	23.90	8.04	9.38	947.10	820.05	1060	1020	0.17	0.07		
40 hp	440	415	4.4	4.1	1926	2,204	3.12	2.66	22.00	25.67	10.15	10.05	924.00	947.10	1020	1020	0.17	0.08		
	470	415	4.4	4.4	1949	2,111	2.87	2.74	24.40	19.47	10.32	8.71	889.35	808.50	1060	1060	0.17	0.09		
"As-measured" Average	480	406	4.4	4.4	1949	2,187	3.08	2.78	20.20	23.21	9.13	9.20	899.00	900.90	1040	1030	0.16	0.07		
Adjusted Average†	1620	1379	14.85	14.87	6578	7,392	10.40	9.40	68.18	78.45	30.81	31.10	3034.13	3045.04	3510	3481	0.54	0.24	3.375	3.38
II	215	215	3.7	3.3	1926	2,018	1.74	1.62	14.10	19.38	6.00	5.33	750.75	912.45	870	870	0.14	0.08		
30 mph	235	200	3.4	3.6	1926	2,042	2.48	2.50	17.70	22.13	5.36	8.04	716.10	693.00	870	790	0.15	0.08		
40 hp	215	200	3.4	3.4	1902	2,111	2.12	2.04	15.20	21.14	6.49	10.66	704.55	820.05	825	825	0.13	0.08		
	165	180	3.2	3.4	1902	1,949	2.12	1.70	20.10	14.16	8.70	5.36	727.65	716.10	825	825	0.14	0.09		
"As-measured" Average	208	199	3.4	3.4	1914	2,030	2.12	1.94	16.78	19.20	6.64	7.35	724.76	782.90	848	828	0.14	0.08		
Adjusted Average	906	874	14.91	14.93	8393	8,912	9.30	8.52	73.58	84.29	29.12	32.27	3178.07	3436.93	3718	3635	0.61	0.35	4.385	4.39
III	165	180	3.6	3.2	1856	2,088	1.49	2.25	19.40	18.50	4.66	5.99	762.30	646.80	825	750	0.24	0.08		
40 mph	200	180	3.2	3.1	1856	1,995	1.86	2.02	17.70	22.13	6.70	10.05	681.45	704.55	720	720	0.19	0.07		
40 hp	190	180	3.2	3.2	1879	1,902	2.37	2.41	19.00	24.78	6.85	7.37	704.55	785.40	750	750	0.14	0.08		
	165	165	3.1	3.2	1879	1,926	2.02	1.95	17.50	17.70	7.33	7.37	612.15	577.50	720	720	0.27	0.07		
"As-measured" Average	180	176	3.3	3.2	1868	1,978	1.94	2.16	18.40	20.78	6.39	7.70	690.11	678.56	754	735	0.21	0.08		
Adjusted Average	812	820	14.88	14.91	8425	9,217	8.75	10.07	82.98	96.83	28.82	35.88	3112.40	3162.09	3401	3425	0.95	0.37	4.51	4.66
IV	270	215	0.9	0.8	557	626	3.21	3.60	19.50	24.78	8.71	10.72	242.55	254.10	280	220	0.12	0.13		
Idle	250	230	1.0	0.8	557	603	3.21	2.76	23.90	22.13	10.05	9.38	231.00	161.70	250	220	0.24	0.17		
	270	215	0.8	0.8	534	534	3.10	2.57	22.60	18.59	10.00	8.04	219.45	207.90	250	220	0.15	0.10		
	235	200	0.8	0.9	534	487	2.62	3.00	26.30	17.90	10.32	12.20	219.45	231.00	280	220	0.22	0.13		
"As-measured" Average	256	215	0.9	0.8	546	563	3.01	2.98	23.08	20.85	9.77	10.09	228.11	213.68	265	220	0.18	0.13		
Adjusted Average	4147	3924	14.58	14.60	8845	10,275	48.76	54.39	373.90	380.51	158.27	184.14	3695.38	3899.66	4293	4015	2.92	2.37	16.20	18.25

---

*Total as ppm formaldehyde.

†Adjusted average is based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" CO and CO_2 measurements.

TABLE 72. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 676
Test Months: 6
Test Mileage: 19,220

Date: February 20 and 21, 1969
Operating Conditions: See Table 23

Operating Conditions	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formal-dehyde	NO_x	NO	SO_2
I	1	A	A	S	A	S	S	A	A(4)	A
20 mph	2	A	A	S	A	A	S	A	S(4)	A
40 hp	3	A	S(4)	S	A	S	A	S	A(4)	A
	4	A	S(4)	S	S	S	A	S	S(4)	A
	5	S	A(4)	A	S	A	A	S	A(4)	S
	6	S	S(4)	A	A	A	A	A(4)	S(4)	S
	7	S	S(4)	A	S	S	S	S(4)	A(4)	S
	8	S	A	A	S	A	S	A	S(4)	S
	U_s	0	6	0	2	5	8	7.5	6	0
II	1	S	S	S	A	S	A	A	A	A
30 mph	2	A	A	S	A	A	S(4)	S	S(4)	A
40 hp	3	A	S(4)	S	S	S	A(4)	A(4)	A(4)	A
	4	A	A(4)	S	A	S	S	S(4)	S(4)	A
	5	S(4)	S(4)	A	S	A	S	S	A(4)	S
	6	A(4)	A(4)	A	S	S	A	S	S(4)	S
	7	S(4)	A	A	S	A	S	A	A(4)	S
	8	S	S	A	A	A	A	A	S(4)	S
	U_s	5	8	0	5	4	7.5	6.5	5	0
III	1	S(4)	S(4)	S	S	S	S	A	A(4)	A
40 mph	2	A(4)	A(4)	S	S	A(4)	A	S	S(4)	A
40 hp	3	S(4)	A(4)	S	A	S(4)	S	A	A(4)	A
	4	A	S(4)	S	S(4)	A	S	S	S(4)	A
	5	A	A(4)	A	A(4)	S	S	A(4)	A(4)	S
	6	A	S(4)	A	A	S	A	S(4)	S(4)	S
	7	S	A(4)	A	S	A	A	S	A(4)	S
	8	S	S	A	A	A	A	A	S	S
	U_s	7	6.5	0	4.5	4.5	3	7.5	7	0
IV	1	A	A(4)	A	A	A	A	A	A	A
Idle	2	A	S(4)	S(4)	S	A	S	A	A	S
0 hp	3	A	A(4)	A(4)	A	S	A	S	A	A
	4	A	S(4)	S(4)	A	A	S	S	A	A
	5	S	A(4)	S	S	S	S	A(4)	S	S
	6	S	A(4)	S	S	S	S	S(4)	S	A
	7	S	S(4)	A	S	A	A	S	S	S
	8	S	S	A	A	S	A	A	S	S
	U_s	0	5.5	7	6	4	7	6.5	0	4

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated fuel with odor additive.
(3) U_s must equal 0, 1, or 2 to show statistical difference with eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 73. COMPARISON OF ODOR PANEL RESPONSES FOR TREATED FUEL VERSUS UNTREATED FUEL - FINAL EVALUATION

Vehicle: Bus 678
Date: February 27 and March 3, 1969

Operating Conditions: See Tables 2 through 5

Operating Conditions	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Untreated	4.9	1.3	1.1	1.0	0.7
	Treated	5.5	1.7	1.5	1.0	1.1
	Net Change	+0.6	+0.4	+0.4	0	+0.4
30 mph at 40 hp	Untreated	4.9	1.4	1.3	1.1	0.8
	Treated	5.4	1.8	1.4	1.0	0.9
	Net Change	+0.5	+0.4	+0.1	-0.1	+0.1
40 mph at 40 hp	Untreated	5.3	1.4	1.3	1.1	0.7
	Treated	5.4	1.7	1.4	1.0	0.9
	Net Change	+0.1	+0.3	+0.1	-0.1	+0.2
Idle	Untreated	5.3	1.5	1.4	1.1	0.8
	Treated	5.7	1.8	1.5	1.2	0.9
	Net Change	+0.4	+0.3	+0.1	+0.1	+0.1
Idle-Acceleration	Untreated	6.3	2.1	1.6	1.0	1.1
	Treated	6.1	2.0	1.9	1.2	1.1
	Net Change	-0.2	-0.1	+0.3	+0.2	0
Deceleration	Untreated	5.4	1.7	1.4	1.1	1.0
	Treated	4.8	1.4	1.2	1.0	0.8
	Net Change	-0.6	-0.3	-0.2	-0.1	-0.2

TABLE 74. VEHICLE ODOR EVALUATION SUMMARY UNTREATED BASE FUEL

Vehicle: Bus 678
Date: February 27, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	5.1	1.6	1.2	1.0	1.0
8	" "	5.0	1.2	1.1	1.1	0.7
11	" "	4.6	1.1	1.1	1.0	0.3
14	" "	4.7	1.2	1.1	0.8	0.6
		4.9	1.3	1.1	1.0	0.7
4	30 mph at 40 hp	4.6	1.3	1.1	1.0	1.0
7	" "	5.1	1.4	1.4	1.1	0.8
10	" "	4.7	1.2	1.1	1.2	0.6
15	" "	5.3	1.7	1.4	0.9	0.7
		4.9	1.4	1.3	1.1	0.8
3	40 mph at 40 hp	4.6	1.2	1.1	1.0	0.4
6	" "	5.3	1.4	1.3	1.1	0.7
12	" "	5.3	1.4	1.2	1.2	0.7
16	" "	5.8	1.6	1.4	1.1	0.8
		5.3	1.4	1.3	1.1	0.7
1	Idle	4.8	1.4	1.2	1.0	0.9
5	"	5.8	1.7	1.6	1.2	0.9
9	"	5.3	1.4	1.3	1.1	0.9
13	"	5.2	1.4	1.4	1.1	0.6
		5.3	1.5	1.4	1.1	0.8
17	Idle-Acceleration	6.2	2.0	1.7	1.0	1.1
19	" "	5.9	1.9	1.4	1.1	1.0
23	" "	6.7	2.3	1.7	1.1	1.2
24	" "	6.2	2.2	1.7	0.9	1.1
		6.3	2.1	1.6	1.0	1.1
18	Deceleration	5.7	1.9	1.3	1.1	0.9
20	"	5.9	1.9	1.7	1.1	1.0
21	"	5.0	1.7	1.2	1.0	1.0
22	"	5.0	1.3	1.2	1.0	1.0
		5.4	1.7	1.4	1.1	1.0

TABLE 74A. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 678
Date: February 27, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"D" Diesel Composite Responses 4	5	6	7	Avg
1	Idle	2	8			4.8
2	20 mph at 40 hp		9	1		5.1
3	40 mph at 40 hp	4	6			4.6
4	30 mph at 40 hp	4	6			4.6
5	Idle		2	8		5.8
6	40 mph at 40 hp		7	3		5.3
7	30 mph at 40 hp	2	5	3		5.1
8	20 mph at 40 hp		10			5.0
9	Idle	2	3	5		5.3
10	30 mph at 40 hp	5	3	2		4.7
11	20 mph at 40 hp	4	6			4.6
12	40 mph at 40 hp	2	3	5		5.3
13	Idle	1	6	3		5.2
14	20 mph at 40 hp	4	5	1		4.7
15	30 mph at 40 hp	1	5	4		5.3
16	40 mph at 40 hp		2	8		5.8
17	Idle-Acceleration			8	2	6.2
18	Deceleration		3	7		5.7
19	Idle-Acceleration		2	7	1	5.9
20	Deceleration		6	4		5.4
21	Deceleration		10			5.0
22	Deceleration		10			5.0
23	Idle-Acceleration			3	7	6.7
24	Idle-Acceleration			8	2	6.2

TABLE 74B. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: February 27, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	Idle	6	4		1.4
2	20 mph at 40 hp	4	6		1.6
3	40 mph at 40 hp	8	2		1.2
4	30 mph at 40 hp	7	3		1.3
5	Idle	3	7		1.7
6	40 mph at 40 hp	6	4		1.4
7	30 mph at 40 hp	6	4		1.4
8	20 mph at 40 hp	8	2		1.2
9	Idle	6	4		1.4
10	30 mph at 40 hp	8	2		1.2
11	20 mph at 40 hp	9	1		1.1
12	40 mph at 40 hp	6	4		1.4
13	Idle	6	4		1.4
14	20 mph at 40 hp	8	2		1.2
15	30 mph at 40 hp	3	7		1.7
16	40 mph at 40 hp	4	6		1.6
17	Idle-Acceleration		10		2.0
18	Deceleration	1	9		1.9
19	Idle-Acceleration	1	9		1.9
20	Deceleration	2	8		1.8
21	Deceleration	3	7		1.7
22	Deceleration	7	3		1.3
23	Idle-Acceleration		7	3	2.3
24	Idle-Acceleration		8	2	2.2

TABLE 74C. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 678
Date: February 27, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Avg
1	Idle	8	2		1.2
2	20 mph at 40 hp	8	2		1.2
3	40 mph at 40 hp	9	1		1.1
4	30 mph at 40 hp	9	1		1.1
5	Idle	4	6		1.6
6	40 mph at 40 hp	7	3		1.3
7	30 mph at 40 hp	6	4		1.4
8	20 mph at 40 hp	9	1		1.1
9	Idle	7	3		1.3
10	30 mph at 40 hp	9	1		1.1
11	20 mph at 40 hp	9	1		1.1
12	40 mph at 40 hp	8	2		1.2
13	Idle	6	4		1.4
14	20 mph at 40 hp	9	1		1.1
15	30 mph at 40 hp	6	4		1.4
16	40 mph at 40 hp	6	4		1.4
17	Idle-Acceleration	4	5	1	1.7
18	Deceleration	7	3		1.3
19	Idle-Acceleration	6	4		1.4
20	Deceleration	3	7		1.7
21	Deceleration	8	2		1.2
22	Deceleration	8	2		1.2
23	Idle-Acceleration	4	5	1	1.7
24	Idle-Acceleration	4	5	1	1.7

TABLE 74D. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 678
Date: February 27, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	Idle		10		1.0
2	20 mph at 40 hp		10		1.0
3	40 mph at 40 hp		10		1.0
4	30 mph at 40 hp		10		1.0
5	Idle		8	2	1.2
6	40 mph at 40 hp		9	1	1.1
7	30 mph at 40 hp		9	1	1.1
8	20 mph at 40 hp		9	1	1.1
9	Idle		9	1	1.1
10	30 mph at 40 hp		8	2	1.2
11	20 mph at 40 hp		10		1.0
12	40 mph at 40 hp		8	2	1.2
13	Idle		9	1	1.1
14	20 mph at 40 hp	2	8		0.8
15	30 mph at 40 hp	1	9		0.9
16	40 mph at 40 hp		9	1	1.1
17	Idle-Acceleration		10		1.0
18	Deceleration		9	1	1.1
19	Idle-Acceleration		9	1	1.1
20	Deceleration	1	7	2	1.1
21	Deceleration	1	8	1	1.0
22	Deceleration		10		1.0
23	Idle-Acceleration	1	7	2	1.1
24	Idle-Acceleration	2	7	1	0.9

TABLE 74E. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL
("P" Pungent Standard)

Vehicle: Bus 678
Date: February 27, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"P" Pungent Responses			
		0	1	2	Avg
1	Idle	1	9		0.9
2	20 mph at 40 hp		10		1.0
3	40 mph at 40 hp	6	4		0.4
4	30 mph at 40 hp		10		1.0
5	Idle	2	7	1	0.9
6	40 mph at 40 hp	3	7		0.7
7	30 mph at 40 hp	2	8		0.8
8	20 mph at 40 hp	3	7		0.7
9	Idle	1	9		0.9
10	30 mph at 40 hp	4	6		0.6
11	20 mph at 40 hp	7	3		0.3
12	40 mph at 40 hp	3	7		0.7
13	Idle	4	6		0.6
14	20 mph at 40 hp	4	6		0.6
15	30 mph at 40 hp	3	7		0.7
16	40 mph at 40 hp	2	8		0.8
17	Idle-Acceleration		9	1	1.1
18	Deceleration	1	9		0.9
19	Idle-Acceleration		10		1.0
20	Deceleration		10		1.0
21	Deceleration		10		1.0
22	Deceleration		10		1.0
23	Idle-Acceleration		8	2	1.2
24	Idle-Acceleration		9	1	1.1

TABLE 75. VEHICLE ODOR EVALUATION SUMMARY ADDITIVE TREATED FUEL

Vehicle: Bus 678
Date: March 3, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	5.7	1.9	1.4	1.1	1.1
5	" "	5.5	1.7	1.6	1.0	1.0
10	" "	5.2	1.6	1.3	1.0	1.1
15	" "	5.4	1.7	1.6	1.0	1.0
		5.5	1.7	1.5	1.0	1.1
1	30 mph at 40 hp	6.1	2.0	1.8	1.1	1.0
6	" "	5.0	1.7	1.1	1.0	0.7
11	" "	4.9	1.6	1.2	1.0	0.8
14	" "	5.4	1.7	1.4	0.9	0.9
		5.4	1.8	1.4	1.0	0.9
2	40 mph at 40 hp	5.7	1.8	1.6	1.0	0.9
7	" "	5.0	1.2	1.2	1.0	0.9
9	" "	5.7	1.9	1.4	1.0	1.0
13	" "	5.3	1.7	1.3	1.0	0.9
		5.4	1.7	1.4	1.0	0.9
4	Idle	5.3	1.7	1.4	1.2	1.0
8	"	5.7	1.7	1.4	1.3	0.9
12	"	5.6	1.7	1.4	1.2	0.9
16	"	6.0	1.9	1.7	1.2	0.8
		5.7	1.8	1.5	1.2	0.9
17	Idle-Acceleration	5.6	1.7	1.6	1.2	0.7
20	" "	6.2	2.0	2.0	1.2	1.2
22	" "	6.6	2.1	2.0	1.2	1.3
23	" "	6.1	2.0	2.0	1.1	1.1
		6.1	2.0	1.9	1.2	1.1
18	Deceleration	4.5	1.4	1.2	1.1	0.6
19	"	4.3	1.3	1.2	1.1	0.7
21	"	5.0	1.4	1.1	0.9	1.0
24	"	5.2	1.6	1.3	1.0	1.0
		4.8	1.4	1.2	1.0	0.8

TABLE 75A. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 678
Date: March 3, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"D" Diesel Composite Responses					
		3	4	5	6	7	Avg
1	30 mph at 40 hp				9	1	6.1
2	40 mph at 40 hp			3	7		5.7
3	20 mph at 40 hp			3	7		5.7
4	Idle			7	3		5.3
5	20 mph at 40 hp			7	1	2	5.5
6	30 mph at 40 hp		1	8	1		5.0
7	40 mph at 40 hp		1	8	1		5.0
8	Idle			4	5	1	5.7
9	40 mph at 40 hp			3	7		5.7
10	20 mph at 40 hp			8	2		5.2
11	30 mph at 40 hp		2	7	1		4.9
12	Idle			4	6		5.6
13	40 mph at 40 hp		2	3	5		5.3
14	30 mph at 40 hp			6	4		5.4
15	20 mph at 40 hp			6	4		5.4
16	Idle			1	8	1	6.0
17	Idle-Acceleration		1	3	5	1	5.6
18	Deceleration	2	2	5	1		4.5
19	Deceleration		8	1	1		4.3
20	Idle-Acceleration				8	2	6.2
21	Deceleration		2	6	2		5.0
22	Idle-Acceleration				4	6	6.6
23	Idle-Acceleration				9	1	6.1
24	Deceleration		1	6	3		5.2

TABLE 75B. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: March 3, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	30 mph at 40 hp		10		2.0
2	40 mph at 40 hp	2	8		1.8
3	20 mph at 40 hp	1	9		1.9
4	Idle	3	7		1.7
5	20 mph at 40 hp	3	7		1.7
6	30 mph at 40 hp	3	7		1.7
7	40 mph at 40 hp	8	2		1.2
8	Idle	3	7		1.7
9	40 mph at 40 hp	1	9		1.9
10	20 mph at 40 hp	4	6		1.6
11	30 mph at 40 hp	4	6		1.6
12	Idle	3	7		1.7
13	40 mph at 40 hp	3	7		1.7
14	30 mph at 40 hp	3	7		1.7
15	20 mph at 40 hp	3	7		1.7
16	Idle	1	9		1.9
17	Idle-Acceleration	3	7		1.7
18	Deceleration	6	4		1.4
19	Deceleration	7	3		1.3
20	Idle-Acceleration		10		2.0
21	Deceleration	6	4		1.4
22	Idle-Acceleration		9	1	2.1
23	Idle-Acceleration		10		2.0
24	Deceleration	4	6		1.6

TABLE 75C. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 678
Date: March 3, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Avg
1	30 mph at 40 hp	2	8		1.8
2	40 mph at 40 hp	4	6		1.6
3	20 mph at 40 hp	6	4		1.4
4	Idle	6	4		1.4
5	20 mph at 40 hp	4	6		1.6
6	30 mph at 40 hp	9	1		1.1
7	40 mph at 40 hp	8	2		1.2
8	Idle	6	4		1.4
9	40 mph at 40 hp	6	4		1.4
10	20 mph at 40 hp	7	3		1.3
11	30 mph at 40 hp	8	2		1.2
12	Idle	6	4		1.4
13	40 mph at 40 hp	7	3		1.3
14	30 mph at 40 hp	6	4		1.4
15	20 mph at 40 hp	4	6		1.6
16	Idle	3	7		1.7
17	Idle-Acceleration	4	6		1.6
18	Deceleration	8	2		1.2
19	Deceleration	8	2		1.2
20	Idle-Acceleration		10		2.0
21	Deceleration	9	1		1.1
22	Idle-Acceleration	1	8	1	2.0
23	Idle-Acceleration		10		2.0
24	Deceleration	7	3		1.3

TABLE 75D. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 678
Date: March 3, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Avg
1	30 mph at 40 hp		9	1	1.1
2	40 mph at 40 hp		10		1.0
3	20 mph at 40 hp		9	1	1.1
4	Idle		8	2	1.2
5	20 mph at 40 hp		10		1.0
6	30 mph at 40 hp		10		1.0
7	40 mph at 40 hp		10		1.0
8	Idle		7	3	1.3
9	40 mph at 40 hp		10		1.0
10	20 mph at 40 hp		10		1.0
11	30 mph at 40 hp		10		1.0
12	Idle		8	2	1.2
13	40 mph at 40 hp		10		1.0
14	30 mph at 40 hp	1	9		0.9
15	20 mph at 40 hp		10		1.0
16	Idle		8	2	1.2
17	Idle-Acceleration		8	2	1.2
18	Deceleration		9	1	1.1
19	Deceleration		9	1	1.1
20	Idle-Acceleration		8	2	1.2
21	Deceleration	1	9		0.9
22	Idle-Acceleration	1	6	3	1.2
23	Idle-Acceleration		9	1	1.1
24	Deceleration		10		1.0

TABLE 75E. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 678
Date: March 3, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	30 mph at 40 hp	1	8	1	1.0
2	40 mph at 40 hp	1	9		0.9
3	20 mph at 40 hp		9	1	1.1
4	Idle		10		1.0
5	20 mph at 40 hp		10		1.0
6	30 mph at 40 hp	3	7		0.7
7	40 mph at 40 hp	1	9		0.9
8	Idle	1	9		0.9
9	40 mph at 40 hp		10		1.0
10	20 mph at 40 hp		9	1	1.1
11	30 mph at 40 hp	2	8		0.8
12	Idle	1	9		0.9
13	40 mph at 40 hp	1	9		0.9
14	30 mph at 40 hp	1	9		0.9
15	20 mph at 40 hp		10		1.0
16	Idle	2	8		0.8
17	Idle-Acceleration	3	6	1	0.7
18	Deceleration	4	6		0.6
19	Deceleration	3	6	1	0.7
20	Idle-Acceleration		8	2	1.2
21	Deceleration		10		1.0
22	Idle-Acceleration		7	3	1.3
23	Idle-Acceleration		9	1	1.1
24	Deceleration	1	8	1	1.0

TABLE 76. COMPUTATION OF "U" STATISTIC TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 678
Test Months: 6
Test Mileage: 20,685

Date: February 27 and March 3, 1969
Operating Conditions: See Tables 2 through 5

Operating Conditions	Relative Ranking	Odor Quality					Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I	1	S	S	S	S	S	IV	1	S	S	S	S	S
20 mph	2	S	S	S	A(4)	S	Idle	2	S	S	S	S	A
40 hp	3	S	S	S	A(4)	S		3	A(4)	S	A(4)	S	S(4)
	4	S	A(4)	S	S(4)	A(4)		4	S(4)	A(4)	A(4)	A(4)	A(4)
	5	A	S(4)	A	A(4)	S(4)		5	A	A(4)	S(4)	A(4)	S(4)
	6	A	A	A	S(4)	A(4)		6	A	S(4)	A(4)	S(4)	A(4)
	7	A	A	A	A(4)	A		7	S	A(4)	S	A(4)	S(4)
	8	A	A	A	S(4)	A		8	A	A	A	A	A
	U_s	0	0.5	0	6.5	1		U_s	3.5	1.5	4.5	1.5	6
II	1	S	S	S(4)	S(4)	S	V	1	A	A	S	S	A
30 mph	2	S	S	A(4)	A(4)	A(4)	Idle-	2	S	S	S(4)	S	S
40 hp	3	A	S	S(4)	A(4)	S(4)	Acceleration	3	A	A(4)	S(4)	S(4)	S(4)
	4	A	A	A	S(4)	A(4)		4	S(4)	S(4)	A(4)	A(4)	A(4)
	5	S	A(4)	S(4)	A(4)	S(4)		5	A(4)	A(4)	S(4)	S(4)	S(4)
	6	S	S(4)	A(4)	A(4)	A		6	S(4)	A	A	A	A(4)
	7	A	A(4)	S(4)	S(4)	S(4)		7	A	S	A	A	S(4)
	8	A	A	A	S	A(4)		8	S	S	A	A	A
	U_s	4	2	6	6	5.5		U_s	6	5	7.5	0.5	6.5
III	1	S	A(4)	S	A(4)	S	VI	1	A	A(4)	A	A	A
40 mph	2	A	S(4)	A(4)	A(4)	S	Deceleration	2	A	S(4)	A(4)	S(4)	A
40 hp	3	S(4)	S	S(4)	S(4)	S		3	S(4)	A	S(4)	A(4)	S
	4	A(4)	S	A(4)	A(4)	S		4	A(4)	A	A(4)	S(4)	S(4)
	5	S(4)	S	S(4)	A(4)	A		5	S(4)	A	S(4)	A(4)	A(4)
	6	A	A	A(4)	S	A		6	A	S	A(4)	S(4)	S(4)
	7	A	A	S(4)	S	A		7	S	S	S(4)	A(4)	A(4)
	8	S	A	A	S	A		8	S	S	S	S(4)	S(4)
	U_s	7	3.5	4.5	2	0		U_s	3	3.5	4.5	7	5

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated fuel with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of the relative rankings is used to compute (T).

TABLE 77. COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 678
Date: February 27 and March 3, 1969

Operating Conditions: See Tables 21 and 22

Constant Speed Results (All open rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity Max	Min	Avg
A. Untreated	20	46	20	18	19.0
Treated	20	46	17	16	16.3
Net Change					-2.7
B. Untreated	25	54	15	15	15.0
Treated	25	58	12	10	11.0
Net Change					-4.0
C. Untreated	30	63	15	13	13.7
Treated	30	70	10	8	8.7
Net Change					-5.0
D. Untreated	35	78	13	11	12.0
Treated	35	79	10	8	8.7
Net Change					-3.3

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings Percent Opacity Max	Min	Avg
Start of engine			
Untreated	11	11	11.0
Treated	11	9	10.0
Net Change			-1.0
During acceleration			
Untreated	11	10	10.3
Treated	8	6	7.0
Net Change			-3.3
After upshift			
Untreated	12	11	11.3
Treated	7	6	6.7
Net Change			-4.6

TABLE 78. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 678
Date: February 27 and March 3, 1969

Operating Conditions: See Table 23
Base Fuel: EM-73-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes*, ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		SO_2, ppm		Adjusting Factor	
	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	1270	1910	4.4	5.5	1,763	1670	3.10	4.84	32.75	36.29	14.07	14.07	831.60	808.50	750	750	0.22	0.18		
20 mph	1200	1910	4.0	5.0	1,763	1717	3.26	4.24	32.75	34.01	11.39	15.59	727.65	716.10	750	900	0.45	0.18		
40 hp	1085	1340	4.9	5.2	1,740	1647	3.03	4.41	30.43	38.49	10.85	15.59	693.00	796.95	720	870	0.48	0.29		
	1200	1000	5.2	4.8	1,786	1670	4.07	4.21	29.21	30.74	11.39	15.76	739.20	820.05	750	870	0.14	0.29		
"As-measured" Average	1189	1540	4.6	5.1	1,763	1676	3.37	4.43	31.29	34.88	11.93	15.25	747.86	785.40	743	848	0.32	0.24		
Adjusted Average†	3775	4404	14.6	14.59	5,598	4793	10.70	12.67	99.35	99.76	37.88	43.62	2374.46	2246.24	2359	2425	1.02	0.69	3.175	2.86
II	235	320	3.1	4.2	1,670	1647	2.62	3.60	25.67	28.32	7.37	10.72	693.00	866.25	640	720	0.32	0.15		
30 mph	250	300	3.1	3.8	1,740	1578	2.13	3.76	29.21	30.43	6.03	12.88	589.05	693.00	600	790	0.63	0.20		
40 hp	250	285	3.8	4.0	1,694	1554	2.77	3.57	25.96	32.54	6.10	10.96	565.95	739.20	600	750	0.57	0.26		
	285	285	3.9	3.9	1,694	1578	2.48	3.83	22.13	32.54	6.70	8.91	589.05	727.65	600	720	0.23	0.27		
"As-measured" Average	255	298	3.5	4.0	1,700	1589	2.50	3.69	25.74	30.96	6.55	10.87	609.26	756.53	610	745	0.44	0.22		
Adjusted Average	1084	1112	14.88	14.92	7,225	5927	10.63	13.76	109.40	115.48	27.84	40.55	2589.36	2821.86	2593	2779	1.87	0.82	4.25	3.73
III	235	235	3.1	3.9	1,531	1438	3.01	2.62	21.24	23.00	10.72	5.99	646.80	727.65	570	610	0.34	0.17		
40 mph	180	200	2.9	3.6	1,624	1415	2.52	3.15	19.47	28.64	8.71	10.85	542.85	704.55	530	750	0.55	0.21		
40 hp	200	220	3.8	4.0	1,578	1462	2.55	2.65	23.92	26.85	10.46	11.53	646.80	704.55	570	640	0.54	0.21		
	220	220	3.8	3.7	1,601	1438	2.62	2.81	23.01	21.70	11.39	9.59	531.30	693.00	530	680	0.28	0.23		
"As-measured" Average	209	219	3.4	3.8	1,584	1438	2.68	2.81	21.91	25.05	10.32	9.49	591.94	707.44	550	670	0.43	0.21		
Adjusted Average	918	861	14.93	14.93	6,954	5651	11.77	11.04	96.18	98.45	45.30	37.30	2598.62	2780.24	2415	2633	1.89	0.83	4.39	3.93
IV	270	250	0.8	0.9	560	557	3.19	2.98	23.01	27.75	9.38	12.88	277.20	242.55	175	280	0.12	0.21		
Idle	235	250	0.8	0.9	603	534	2.87	3.14	23.01	25.06	10.05	13.56	254.10	300.30	175	280	0.17	0.18		
	235	220	0.8	1.0	603	510	3.26	2.93	23.27	27.12	10.17	15.07	231.00	242.55	175	280	0.21	0.22		
	250	220	0.9	0.9	626	510	2.96	3.23	25.55	30.16	10.66	14.57	231.00	231.00	220	280	0.14	0.26		
"As-measured" Average	248	235	0.8	0.9	603	528	3.07	3.07	23.71	27.52	10.07	14.02	248.33	254.10	186	280	0.16	0.22		
Adjusted Average	4514	3819	14.56	14.63	10,975	8580	55.87	49.89	431.52	447.20	183.27	227.83	4519.61	4129.13	3385	4550	2.91	3.58	18.2	16.25

---

*Total as ppm formaldehyde.

†Adjusted average is based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 79. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 678
Test Months: 6
Test Mileage: 20,685

Date: February 27 and March 3, 1969
Operating Conditions: See Table 23

Operating Conditions	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formal-dehyde	NO_x	NO	SO_2
I 20 mph 40 hp	1	A	S	A	S	S	S	S	S	S
	2	S	S	A	S	S	S	A	S(4)	A
	3	S	A	A	S	A	S	S	S(4)	A
	4	S	S	A	S	S	S(4)	S	A(4)	S
	5	S	A	S	A	S	A(4)	A	S(4)	A
	6	A	A(4)	S	A	A	A	A	A	A
	7	A	S(4)	S	A	A	A	A	A	S
	8	A	A	S	A	A	A	S	A	S
	U_s	4	3.5	0	0	2	0.5	6	1.5	6
II 30 mph 40 hp	1	S	S	A	S	S	S	S	S	A
	2	S	S	A	S	S	S	S	S	A
	3	S	A(4)	A	S	S	S	S	S	A
	4	A(4)	S(4)	A	S	A	S	S(4)	S	A
	5	S(4)	A(4)	S	A	S	A	A(4)	A	S
	6	A(4)	S(4)	S	A	A	A	A	A	S
	7	A	A	S	A	A	A	A	A	S
	8	A	A	S	A	A	A	A	A	S
	U_s	1	2	0	0	1	0	0.5	0	0
III 40 mph 40 hp	1	S	S	A	S	S	A	S	S	A
	2	A(4)	S	A	S	S	S	S	S	A
	3	S(4)	A	A	S(4)	A	A	S	S	A
	4	A(4)	A	A	A(4)	A	S	S	S	A
	5	S(4)	S	S	A	S	S	A	A	S
	6	A(4)	S	S	A	S	A	A	A	S
	7	A(4)	A	S	S	A	S	A	A	S
	8	S(4)	A	S	A	A	A	A	A	S
	U_s	6	4	0	3.5	4	8	0	0	0
IV Idle 0 hp	1	A	S	A	S	S	S	S(4)	S	S
	2	A	S	A	A	S	S	A(4)	S	S
	3	S	S	A	S	S	S	S(4)	S	S
	4	S	A(4)	A	A	A	S	A	S	A
	5	A(4)	A(4)	S	A	S	A	A	A	S(4)
	6	S(4)	S(4)	S	S	A	A	S	A	A(4)
	7	A(4)	A(4)	S	A	A	A	S	A	A
	8	S	A	S	S	A	A	A	A	A
	U_s	5	1.5	0	8	1	0	7	0	1.5

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated fuel with odor additive.
(3) U_s must equal 0, 1, or 2 to show statistical difference with eight relative rankings.
U_s must equal 0 or 1 to show significant difference with seven relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).
(5) Measured data within accuracy and reliability of measurement method employed.
No statistical difference exists.

TABLE 80. COMPARISON OF ODOR PANEL RESPONSES FOR TREATED FUEL VERSUS UNTREATED FUEL - FINAL EVALUATION

Vehicle: Bus 680
Date: March 4 and 5, 1969

Operating Conditions: See Tables 2 through 5

Operating Conditions	Fuel	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
20 mph at 40 hp	Untreated	5.8	1.8	1.2	1.1	1.1
	Treated	5.7	1.8	1.5	1.2	1.0
	Net Change	-0.1	0	+0.3	+0.1	-0.1
30 mph at 40 hp	Untreated	5.1	1.4	1.2	1.0	0.7
	Treated	5.0	1.5	1.3	1.0	0.9
	Net Change	-0.1	+0.1	+0.1	0	+0.2
40 mph at 40 hp	Untreated	5.1	1.4	1.1	1.0	0.8
	Treated	5.4	1.6	1.5	1.1	1.0
	Net Change	+0.3	+0.2	+0.4	+0.1	+0.2
Idle	Untreated	5.6	1.8	1.2	1.1	1.0
	Treated	6.4	2.1	1.8	1.5	1.1
	Net Change	+0.8	+0.3	+0.6	+0.4	+0.1
Idle - Acceleration	Untreated	6.1	1.9	1.7	1.2	1.1
	Treated	6.3	2.1	1.9	1.2	1.3
	Net Change	+0.2	+0.2	+0.2	0	+0.2
Deceleration	Untreated	5.7	1.8	1.5	1.3	1.0
	Treated	5.7	1.9	1.7	1.2	1.0
	Net Change	0	-0.1	+0.2	+0.1	0

TABLE 81. VEHICLE ODOR EVALUATION SUMMARY UNTREATED BASE FUEL

Vehicle: Bus 680
Date: March 5, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	6.0	1.9	1.1	1.1	1.1
8	" "	5.7	1.7	1.3	1.0	1.0
11	" "	5.7	1.9	1.1	1.1	1.1
14	" "	5.7	1.7	1.4	1.2	1.1
		5.8	1.8	1.2	1.1	1.1
4	30 mph at 40 hp	4.9	1.2	1.1	1.0	0.4
7	" "	5.3	1.5	1.1	0.9	0.8
10	" "	5.2	1.5	1.3	1.0	0.8
15	" "	4.8	1.3	1.2	0.9	0.8
		5.1	1.4	1.2	1.0	0.7
3	40 mph at 40 hp	5.0	1.2	1.0	1.0	0.5
6	" "	5.1	1.8	1.3	0.9	0.9
12	" "	5.0	1.2	1.2	1.1	0.9
16	" "	5.1	1.5	1.0	1.0	0.8
		5.1	1.4	1.1	1.0	0.8
1	Idle	5.1	1.5	1.2	1.1	0.9
5	"	5.7	1.8	1.0	1.1	0.9
9	"	5.8	1.8	1.3	1.0	1.0
13	"	5.9	1.9	1.3	1.2	1.0
		5.6	1.8	1.2	1.1	1.0
17	Idle-Acceleration	5.4	1.5	1.2	1.1	0.9
19	" "	5.9	2.0	1.7	1.1	1.1
23	" "	6.7	2.1	1.9	1.2	1.2
24	" "	6.5	2.1	1.9	1.2	1.2
		6.1	1.9	1.7	1.2	1.1
18	Deceleration	5.4	1.5	1.1	1.1	0.9
20	"	6.0	1.8	1.8	1.1	1.1
21	"	6.1	1.9	1.8	1.2	1.0
22	"	5.4	1.9	1.2	1.7	1.0
		5.7	1.8	1.5	1.3	1.0

TABLE 81A. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL
("D" Diesel Composite Results)

Vehicle: Bus 680
Date: March 5, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Conditions	"D" Diesel Composite Responses				
		4	5	6	7	Avg
1	Idle		9	1		5.1
2	20 mph at 40 hp			10		6.0
3	40 mph at 40 hp		10			5.0
4	30 mph at 40 hp	2	7	1		4.9
5	Idle		3	7		5.7
6	40 mph at 40 hp		9	1		5.1
7	30 mph at 40 hp	1	5	4		5.3
8	20 mph at 40 hp		3	7		5.7
9	Idle		2	8		5.8
10	30 mph at 40 hp	1	6	3		5.2
11	20 mph at 40 hp		3	7		5.7
12	40 mph at 40 hp		10			5.0
13	Idle		1	9		5.9
14	20 mph at 40 hp		3	7		5.7
15	30 mph at 40 hp	3	6	1		4.8
16	40 mph at 40 hp		9	1		5.1
17	Idle-Acceleration		7	2	1	5.4
18	Deceleration		6	4		5.4
19	Idle-Acceleration		1	9		5.9
20	Deceleration		1	8	1	6.0
21	Deceleration			9	1	6.1
22	Deceleration		7	2	1	5.4
23	Idle-Acceleration			3	7	6.7
24	Idle-Acceleration			5	5	6.5

TABLE 81B. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: March 5, 1969

Operating Conditions: See Table 2 through 5

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	Idle	5	5		1.5
2	20 mph at 40 hp	1	9		1.9
3	40 mph at 40 hp	8	2		1.2
4	30 mph at 40 hp	8	2		1.2
5	Idle	2	8		1.8
6	40 mph at 40 hp	2	8		1.8
7	30 mph at 40 hp	5	5		1.5
8	20 mph at 40 hp	3	7		1.7
9	Idle	2	8		1.8
10	30 mph at 40 hp	5	5		1.5
11	20 mph at 40 hp	1	9		1.9
12	40 mph at 40 hp	8	2		1.2
13	Idle	1	9		1.9
14	20 mph at 40 hp	3	7		1.7
15	30 mph at 40 hp	7	3		1.3
16	40 mph at 40 hp	5	5		1.5
17	Idle-Acceleration	6	3	1	1.5
18	Deceleration	5	5		1.5
19	Idle-Acceleration		10		2.0
20	Deceleration	2	8		1.8
21	Deceleration	1	9		1.9
22	Deceleration	1	9		1.9
23	Idle-Acceleration		9	1	2.1
24	Idle-Acceleration	1	7	2	2.1

TABLE 81C. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: March 5, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"O" Oily Responses 1	2	Avg
1	Idle	8	2	1.2
2	20 mph at 40 hp	9	1	1.1
3	40 mph at 40 hp	10		1.0
4	30 mph at 40 hp	9	1	1.1
5	Idle	10		1.0
6	40 mph at 40 hp	7	3	1.3
7	30 mph at 40 hp	9	1	1.1
8	20 mph at 40 hp	7	3	1.3
9	Idle	7	3	1.3
10	30 mph at 40 hp	7	3	1.3
11	20 mph at 40 hp	9	1	1.1
12	40 mph at 40 hp	8	2	1.2
13	Idle	7	3	1.3
14	20 mph at 40 hp	6	4	1.4
15	30 mph at 40 hp	8	2	1.2
16	40 mph at 40 hp	10		1.0
17	Idle-Acceleration	8	2	1.2
18	Deceleration	9	1	1.1
19	Idle-Acceleration	3	7	1.7
20	Deceleration	2	8	1.8
21	Deceleration	2	8	1.8
22	Deceleration	8	2	1.2
23	Idle-Acceleration	1	9	1.9
24	Idle-Acceleration	1	9	1.9

TABLE 81D. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL
("A" Aromatic Standard)

Vehicle: Bus 680
Date: March 5, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	Idle		9	1	1.1
2	20 mph at 40 hp		9	1	1.1
3	40 mph at 40 hp		10		1.0
4	30 mph at 40 hp		10		1.0
5	Idle		9	1	1.1
6	40 mph at 40 hp	1	9		0.9
7	30 mph at 40 hp	1	9		0.9
8	20 mph at 40 hp		10		1.0
9	Idle	1	8	1	1.0
10	30 mph at 40 hp	1	8	1	1.0
11	20 mph at 40 hp		9	1	1.1
12	40 mph at 40 hp		9	1	1.1
13	Idle		8	2	1.2
14	20 mph at 40 hp	1	6	3	1.2
15	30 mph at 40 hp	1	9		0.9
16	40 mph at 40 hp		10		1.0
17	Idle		9	1	1.1
18	Deceleration		9	1	1.1
19	Idle-Acceleration	1	7	2	1.1
20	Deceleration		9	1	1.1
21	Deceleration		8	2	1.2
22	Deceleration		3	7	1.7
23	Idle-Acceleration		8	2	1.2
24	Idle-Acceleration		8	2	1.2

TABLE 81E. VEHICLE ODOR EVALUATION RESULTS - UNTREATED FUEL
("P" Pungent Standard)

Vehicle: Bus 680
Date: March 5, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	Idle	1	9		0.9
2	20 mph at 40 hp		9	1	1.1
3	40 mph at 40 hp	5	5		0.5
4	30 mph at 40 hp	7	2	1	0.4
5	Idle	1	9		0.9
6	40 mph at 40 hp	1	9		0.9
7	30 mph at 40 hp	2	8		0.8
8	20 mph at 40 hp		10		1.0
9	Idle		10		1.0
10	30 mph at 40 hp	2	8		0.8
11	20 mph at 40 hp		9	1	1.1
12	40 mph at 40 hp	1	9		0.9
13	Idle		10		1.0
14	20 mph at 40 hp		9	1	1.1
15	30 mph at 40 hp	3	6	1	0.8
16	40 mph at 40 hp	2	8		0.8
17	Idle-Acceleration	1	9		0.9
18	Deceleration	2	7	1	0.9
19	Idle-Acceleration		9	1	1.1
20	Deceleration		9	1	1.1
21	Deceleration		10		1.0
22	Deceleration		10		1.0
23	Idle-Acceleration		8	2	1.2
24	Idle-Acceleration		8	2	1.2

TABLE 82. VEHICLE ODOR EVALUATION SUMMARY ADDITIVE TREATED FUEL

Vehicle: Bus 680
Date: March 4, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	20 mph at 40 hp	5.6	1.8	1.4	1.1	1.0
8	" "	5.7	1.7	1.4	1.3	1.0
12	" "	5.9	2.0	1.7	1.4	1.0
14	" "	5.6	1.7	1.6	1.1	1.0
		5.7	1.8	1.5	1.2	1.0
2	30 mph at 40 hp	4.3	1.3	1.2	1.0	0.6
5	" "	5.1	1.6	1.3	1.0	0.8
11	" "	5.6	1.7	1.7	1.0	1.1
13	" "	4.8	1.4	1.0	1.0	1.0
		5.0	1.5	1.3	1.0	0.9
1	40 mph at 40 hp	5.0	1.3	1.2	1.0	1.0
7	" "	5.7	1.7	1.6	1.2	1.0
9	" "	4.9	1.6	1.3	1.0	0.9
16	" "	6.1	1.9	1.7	1.2	1.0
		5.4	1.6	1.5	1.1	1.0
3	Idle	5.8	1.8	1.8	1.3	1.0
6	"	6.3	2.2	1.9	1.4	1.1
10	"	6.7	2.0	1.9	1.6	1.0
15	"	6.6	2.2	1.7	1.5	1.1
		6.4	2.1	1.8	1.5	1.1
19	Idle-Acceleration	6.7	2.0	2.0	1.3	1.3
21	" "	6.5	2.1	2.0	1.2	1.3
22	" "	6.3	2.3	1.7	1.0	1.3
24	" "	5.8	2.0	1.9	1.2	1.3
		6.3	2.1	1.9	1.2	1.3
17	Deceleration	5.5	1.7	1.8	1.1	1.0
18	"	5.7	1.7	1.6	1.3	1.0
20	"	6.0	2.1	1.7	1.2	1.1
23	"	5.7	1.9	1.8	1.3	0.8
		5.7	1.9	1.7	1.2	1.0

TABLE 82A. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("D" Diesel Composite Results)

Vehicle: Bus 680
Date: March 4, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"D" Diesel Composite Responses					
		3	4	5	6	7	Avg
1	40 mph at 40 hp			10			5.0
2	30 mph at 40 hp		7	3			4.3
3	Idle	1		1	6	2	5.8
4	20 mph at 40 hp			4	6		5.6
5	30 mph at 40 hp			9	1		5.1
6	Idle				7	3	6.3
7	40 mph at 40 hp			4	5	1	5.7
8	20 mph at 40 hp			4	5	1	5.7
9	40 mph at 40 hp		2	7	1		4.9
10	Idle				3	7	6.7
11	30 mph at 40 hp			4	6		5.6
12	20 mph at 40 hp			2	7	1	5.9
13	30 mph at 40 hp		2	8			4.8
14	20 mph at 40 hp			4	6		5.6
15	Idle				4	6	6.6
16	40 mph at 40 hp			1	7	2	6.1
17	Deceleration		1	5	2	2	5.5
18	Deceleration			6	1	3	5.7
19	Idle-Acceleration				3	7	6.7
20	Deceleration			2	6	2	6.0
21	Idle-Acceleration			1	3	6	6.5
22	Idle-Acceleration			1	5	4	6.3
23	Deceleration			4	5	1	5.7
24	Idle-Acceleration			2	8		5.8

TABLE 82B. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 680
Date: March 4, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"B" Burnt-Smoky Responses				
		0	1	2	3	Avg
1	40 mph at 40 hp		7	3		1.3
2	30 mph at 40 hp		7	3		1.3
3	Idle		2	8		1.8
4	20 mph at 40 hp		2	8		1.8
5	30 mph at 40 hp		4	6		1.6
6	Idle			8	2	2.2
7	40 mph at 40 hp		3	7		1.7
8	20 mph at 40 hp		3	7		1.7
9	40 mph at 40 hp		4	6		1.6
10	Idle		1	8	1	2.0
11	30 mph at 40 hp		3	7		1.7
12	20 mph at 40 hp			10		2.0
13	30 mph at 40 hp		6	4		1.4
14	20 mph at 40 hp		3	7		1.7
15	Idle			8	2	2.2
16	40 mph at 40 hp		1	9		1.9
17	Deceleration		5	3	2	1.7
18	Deceleration		5	3	2	1.7
19	Idle-Acceleration	1		7	2	2.0
20	Deceleration		1	7	2	2.1
21	Idle-Acceleration		1	7	2	2.1
22	Idle-Acceleration		1	5	4	2.3
23	Deceleration		1	9		1.9
24	Idle-Acceleration			10		2.0

TABLE 82C. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("O" Oily Standard)

Vehicle: Bus 680
Date: March 4, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"O" Oily Responses				
		0	1	2	3	Avg
1	40 mph at 40 hp		8	2		1.2
2	30 mph at 40 hp		8	2		1.2
3	Idle		2	8		1.8
4	20 mph at 40 hp		6	4		1.4
5	30 mph at 40 hp		7	3		1.3
6	Idle		1	9		1.9
7	40 mph at 40 hp		4	6		1.6
8	20 mph at 40 hp		6	4		1.4
9	40 mph at 40 hp		7	3		1.3
10	Idle		1	9		1.9
11	30 mph at 40 hp		3	7		1.7
12	20 mph at 40 hp		3	7		1.7
13	30 mph at 40 hp		10			1.0
14	20 mph at 40 hp		4	6		1.6
15	Idle		3	7		1.7
16	40 mph at 40 hp		3	7		1.7
17	Deceleration		2	8		1.8
18	Deceleration		4	6		1.6
19	Idle-Acceleration		2	6	2	2.0
20	Deceleration		4	5	1	1.7
21	Idle-Acceleration		2	6	2	2.0
22	Idle-Acceleration	1	2	6	1	1.7
23	Deceleration		2	8		1.8
24	Idle-Acceleration		1	9		1.9

TABLE 82D. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("A" Aromatic Standard)

Vehicle: Bus 680
Date: March 4, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	40 mph at 40 hp		10		1.0
2	30 mph at 40 hp		10		1.0
3	Idle		7	3	1.3
4	20 mph at 40 hp		9	1	1.1
5	30 mph at 40 hp		10		1.0
6	Idle		6	4	1.4
7	40 mph at 40 hp		8	2	1.2
8	20 mph at 40 hp		7	3	1.3
9	40 mph at 40 hp	1	8	1	1.0
10	Idle		4	6	1.6
11	30 mph at 40 hp	1	8	1	1.0
12	20 mph at 40 hp		6	4	1.4
13	30 mph at 40 hp		10		1.0
14	20 mph at 40 hp		9	1	1.1
15	Idle	1	3	6	1.5
16	40 mph at 40 hp	1	6	3	1.2
17	Deceleration		9	1	1.1
18	Deceleration		7	3	1.3
19	Idle-Acceleration	1	5	4	1.3
20	Deceleration		8	2	1.2
21	Idle-Acceleration		8	2	1.2
22	Idle-Acceleration	1	8	1	1.0
23	Deceleration		7	3	1.3
24	Idle-Acceleration	1	6	3	1.2

TABLE 82E. VEHICLE ODOR EVALUATION RESULTS - ADDITIVE TREATED FUEL

("P" Pungent Standard)

Vehicle: Bus 680
Date: March 4, 1969

Operating Conditions: See Tables 2 through 5

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	40 mph at 40 hp		10		1.0
2	30 mph at 40 hp	4	6		0.6
3	Idle	1	8	1	1.0
4	20 mph at 40 hp	1	8	1	1.0
5	30 mph at 40 hp	2	8		0.8
6	Idle		9	1	1.1
7	40 mph at 40 hp	1	8	1	1.0
8	20 mph at 40 hp	1	8	1	1.0
9	40 mph at 40 hp	1	9		0.9
10	Idle	1	8	1	1.0
11	30 mph at 40 hp		9	1	1.1
12	20 mph at 40 hp	1	8	1	1.0
13	30 mph at 40 hp		10		1.0
14	20 mph at 40 hp		10		1.0
15	Idle		9	1	1.1
16	40 mph at 40 hp		10		1.0
17	Deceleration	1	8	1	1.0
18	Deceleration	1	8	1	1.0
19	Idle-Acceleration		7	3	1.3
20	Deceleration		9	1	1.1
21	Idle-Acceleration	1	5	4	1.3
22	Idle-Acceleration		7	3	1.3
23	Deceleration	2	8		0.8
24	Idle-Acceleration		7	3	1.3

TABLE 83. COMPUTATION OF "U" STATISTIC TO ESTABLISH SIGNIFICANT DIFFERENCE BETWEEN ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 680
Test Months: 6
Test Miles: 17,690

Date: March 4 and 5, 1969
Operating Conditions: See Tables 2 through 5

Operating Conditions	Relative Ranking	Odor Quality					Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I	1	A	A(4)	S	S	A(4)	IV	1	S	S	S	S	S
20 mph	2	A	S(4)	S	A(4)	A(4)	Idle	2	S	S(4)	S	S	S
40 hp	3	S(4)	A(4)	S	S(4)	S(4)		3	A(4)	A(4)	S	S	A(4)
	4	S(4)	S(4)	A(4)	A(4)	A(4)		4	S(4)	S(4)	S	S	S(4)
	5	A(4)	A	S(4)	S(4)	A(4)		5	S	S	A	A	A(4)
	6	S(4)	S	A(4)	S	S		6	A	A	A	A	S(4)
	7	A	S	A	A	S		7	A	A	A	A	A
	8	S	A	A	A	S		8	A	A	A	A	A
	U_s	4.5	8	1	4	2		U_s	1.5	2	0	0	1
II	1	A	S	A	S	S	V	1	S	S	S	A	S
30 mph	2	A(4)	A(4)	S	S	A	Idle-Acceleration	2	A	A(4)	A(4)	S	S
40 hp	3	S(4)	S(4)	S	A(4)	S(4)		3	S	S(4)	S(4)	S	S
	4	S	A	A(4)	A(4)	S(4)		4	A	A(4)	S(4)	A(4)	S
	5	A	S	S(4)	S(4)	A(4)		5	A(4)	S(4)	A(4)	S(4)	A
	6	S	S	A(4)	S(4)	S(4)		6	S(4)	A(4)	S(4)	A(4)	A
	7	S	A	S(4)	A(4)	A		7	A(4)	S(4)	A	S(4)	A
	8	A	A	A	A(4)	A		8	S(4)	A	A	A	A
	U_s	6.5	4.5	6	4	4.5		U_s	7	6	3.5	7	0
III	1	A	S	S	S	S	VI	1	S	S	S	S(4)	A
40 mph	2	S(4)	S	S	A(4)	S	Deceleration	2	S	A	S	A(4)	S
40 hp	3	A(4)	A	A(4)	S(4)	S(4)		3	A	A	A	S(4)	A(4)
	4	S(4)	S	S(4)	A(4)	A(4)		4	A	S	A	A(4)	S(4)
	5	S(4)	A	A(4)	S(4)	S(4)		5	A	S(4)	S(4)	S(4)	A(4)
	6	S	A	S(4)	S	A		6	S(4)	A(4)	A(4)	A	S(4)
	7	A	S	A	A	A		7	A(4)	S(4)	S(4)	A	A(4)
	8	A	A	A	A	A		8	S	A	A(4)	S	S(4)
	U_s	7	4	2	4	1		U_s	7.5	7	6	6.5	7.5

(1) "S" stands for EM-73-F untreated fuel.
(2) "A" stands for EM-73-F treated fuel with odor additive.
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of the relative rankings is used to compute (T).

TABLE 84. COMPARISON OF SMOKE READINGS WITH ADDITIVE TREATED FUEL VERSUS UNTREATED FUEL

Vehicle: Bus 680 Date: March 4 and 5, 1969	Operating Conditions: See Tables 21 and 22

Constant Speed Results (All open rack--maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity Max	Min	Avg
A. Untreated	20	42	11	10	10.3
Treated	20	42	9	9	9.0
Net Change					-1.3
B. Untreated	25	53	8	8	8.0
Treated	25	54	7	7	7.0
Net Change					-1.0
C. Untreated	30	69	6	6	6.0
Treated	30	67	6	6	6.0
Net Change					0
D. Untreated	35	81	5	5	5.0
Treated	35	80	5	4	4.3
Net Change					-0.7

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity Max	Min	Avg
Start of engine			
Untreated	7	7	7.0
Treated	6	5	5.3
Net Change			-1.7
During acceleration			
Untreated	5	4	4.3
Treated	7	4	5.3
Net Change			+1.0
After upshift			
Untreated	6	6	6.0
Treated	6	5	5.3
Net Change			-0.7

TABLE 85. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 680
Date: March 4 and 5, 1969

Operating Conditions. See Table 23
Base Fuel: EM-73-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes*, ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		SO_2, ppm		Adjusting Factor	
	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive	Base	Additive
I	2340	2280	5.1	4.8	1,856	1,856	6.42	4.69	60.52	40.94	27.63	18.87	820.05	773.85	720	850	0.31	0.22		
20 mph	1995	1800	4.7	4.6	1,879	1,856	5.43	5.34	36.29	36.90	25.46	17.71	727.65	889.35	600	825	0.42	0.24		
40 hp	2340	1540	4.9	4.6	1,832	1,694	5.83	5.09	41.08	36.56	25.90	19.43	796.95	612.15	720	825	0.25	0.28		
	2140	2200	4.8	4.9	1,856	1,624	6.61	4.84	32.04	38.13	24.94	17.63	877.80	843.15	720	825	0.35	0.27		
"As-measured" Average	2204	1955	4.9	4.7	1,856	1,756	6.07	4.99	42.48	38.13	25.98	18.41	805.61	779.63	690	831	0.33	0.25		
Adjusted Average†	6447	5982	14.33	14.38	5,429	5,379	17.75	15.27	124.25	116.68	75.99	56.33	2356.41	2385.67	2018	2543	0.97	0.77	2.925	3.06
II	340	320	4.0	4.1	1,763	1,740	3.60	3.09	29.94	19.58	17.39	12.81	785.40	877.80	680	850	0.31	0.15		
30 mph	285	285	3.9	3.8	1,856	1,786	2.73	3.97	25.67	37.38	14.07	17.52	843.15	912.45	680	850	0.40	0.20		
40 hp	340	250	3.8	3.8	1,717	1,717	3.35	4.59	28.02	31.82	15.07	14.49	750.75	820.05	680	750	0.31	0.25		
	250	270	3.7	3.8	1,647	1,647	3.37	4.22	28.32	47.84	14.74	14.64	773.85	762.30	680	770	0.39	0.22		
"As-measured" Average	304	281	3.9	3.9	1,746	1,723	3.26	3.97	27.99	34.16	15.32	14.87	788.29	843.15	680	805	0.35	0.21		
Adjusted Average	1161	1073	14.90	14.90	6,670	6,582	12.45	15.17	106.92	130.49	58.52	56.80	3011.27	3220.83	2598	3075	1.34	0.80	3.82	3.82
III	235	235	3.8	4.0	1,554	1,624	4.34	2.45	30.16	28.32	27.20	11.39	693.00	843.15	640	790	0.31	0.20		
40 mph	215	200	3.7	3.6	1,694	1,694	4.12	3.23	27.31	36.90	17.98	15.66	693.00	924.00	680	720	0.39	0.22		
40 hp	200	200	3.7	3.8	1,578	1,601	3.87	3.00	28.19	32.54	19.31	14.39	600.60	785.40	600	720	0.38	0.22		
	250	235	3.8	3.6	1,508	1,438	3.62	3.62	24.78	38.13	20.10	18.33	508.20	785.40	570	680	0.39	0.28		
"As-measured" Average	225	218	3.8	3.8	1,584	1,589	3.99	3.08	27.61	33.97	21.15	14.94	623.70	834.49	623	728	0.37	0.23		
Adjusted Average	884	857	14.93	14.93	6,225	6,245	15.68	12.10	108.51	133.50	83.12	58.71	2451.14	3279.55	2448	2861	1.45	0.90	3.93	3.93
IV	320	285	0.9	1.0	1,322	2,622	4.69	4.81	55.76	44.50	22.11	19.55	311.85	292.55	210	260	0.21	0.17		
Idle	340	320	0.9	1.0	2,622	2,459	4.20	6.42	52.22	52.20	28.14	17.52	254.10	300.30	210	280	0.22	0.18		
	305	305	0.9	0.8	2,552	2,436	6.66	6.45	67.50	43.63	22.47	17.25	277.20	300.30	210	250	0.25	0.18		
	285	340	0.9	0.9	1,369	1,438	5.68	5.96	55.76	43.71	20.77	21.15	265.65	300.30	210	250	0.18	0.24		
"As-measured" Average	313	313	0.7	0.9	1,966	2,239	5.31	5.91	57.81	46.01	23.37	18.87	277.20	298.36	210	265	0.22	0.19		
Adjusted Average	5039	5039	14.49	14.49	31,653	36,048	85.49	95.15	930.74	740.76	376.26	303.81	4462.92	4803.60	3381	4267	3.54	3.06	16.1	16.1

---

*Total as ppm formaldehyde.

†Adjusted average is based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 86. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS DATA ADDITIVE TREATED FUEL VERSUS UNTREATED BASE FUEL

Vehicle: Bus 680
Test Months: 6
Test Mileage: 17,690

Date: March 4 and 5, 1969
Operating Conditions: See Table 23

Operating Conditions	Relative Ranking	CO	CO_2	HHC	Acrolein	Aldehydes	Formal-dehyde	NO_x	NO	SO_2
I	1	A	A	A	A	S	A	A	S	A
20 mph	2	A	A	A	A	S	A	S	S	A
40 hp	3	S	S	S	A	A	A	A	S	S
	4	S	A(4)	A(4)	A	A	A	S	S	A
	5	A	S(4)	S(4)	S	A	S	S	A	A
	6	A	A(4)	A(4)	A	A	S	A	A	S
	7	S	S(4)	S(4)	S	S	S	S	A	S
	8	S	S	S	S	S	S	A	A	S
	U_s	8	4	4	0	8	0	8	0	2
II	1	A(4)	S	A(4)	S	A	A	S	S	A
30 mph	2	S(4)	A(4)	S(4)	A	S	S	A	S	A
40 hp	3	A	A(4)	A(4)	S	S	A	S	S	A
	4	S(4)	S(4)	S(4)	S	S	A	S	S	A
	5	A(4)	A(4)	A	S	S	S	A	A	S
	6	A	S	S	A	A	S	S	A	S
	7	S	S	A	A	A	S	A	A	S
	8	S	A	S	A	A	A	A	A	S
	U_s	5	7.5	7	3	4	6	4	0	0
III	1	A(4)	A	A	A	S	A	S	S	A
40 mph	2	S(4)	A	S	A	S	A	S	S	A
40 hp	3	A(4)	S	S	A	S	A	S	S	A
	4	S	S	S	A(4)	A	S	S	S(4)	A
	5	A(4)	S(4)	A	S(4)	S	A	A	A(4)	S
	6	S(4)	A(4)	A	S	A	S	A	A	S
	7	A(4)	S(4)	S(4)	S	A	S	A	A	S
	8	S	A	A(4)	S	A	S	A	A	S
	U_s	6	7	6.5	0.5	1	1	0	0.5	0
IV	1	S(4)	A	S	S	A	A	S	S	A
Idle	2	A(4)	S(4)	S	S	A	A	S	S	A(4)
0 hp	3	S(4)	S(4)	A	A	A	A	S	S	S(4)
	4	A(4)	A(4)	A	S	A	S	A	S	A(4)
	5	S(4)	S(4)	A	A	S	A	A	A	S
	6	A(4)	S(4)	S	A	S	S	A	A	S
	7	S(4)	A	A(4)	A	S	S	A	A	A
	8	A(4)	A	S(4)	S	S	S	S	A	S
	U_s	8	6	6.5	5	0	1	4	0	4

(1) "S" stands for EM-73-F untreated fuel.

(2) "A" stands for EM-73-F treated fuel with odor additive.

(3) U_s must equal 0, 1, or 2 to show statistical difference with eight relative rankings. U_s must equal 0 or 1 to show significant difference with seven relative rankings.

(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

(5) Measured data within accuracy and reliability of measurement method employed. No statistical difference exists.

TABLE 87. VEHICLE ODOR EVALUATION SUMMARY RECOMMENDED TREATMENT LEVEL

Vehicle: Bus 676
Date: February 24, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-91-F

		Average Panel Responses				
Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	4.9	1.2	1.0	1.0	1.0
5	" "	5.1	1.3	1.1	1.1	0.8
10	" "	5.2	1.4	1.2	0.9	1.0
15	" "	5.4	1.6	1.2	1.1	1.0
		5.2	1.4	1.1	1.0	1.0
1	30 mph at 40 hp	5.4	1.4	1.1	1.0	1.0
6	" "	5.3	1.6	1.2	1.1	1.0
11	" "	5.9	1.7	1.4	0.9	1.0
14	" "	5.4	1.7	1.2	1.0	1.0
		5.5	1.6	1.2	1.0	1.0
2	40 mph at 40 hp	5.5	1.2	1.2	1.1	1.0
7	" "	5.4	1.4	1.3	1.1	0.9
9	" "	6.0	1.9	1.5	1.1	1.0
13	" "	5.8	1.9	1.5	1.1	1.1
		5.7	1.6	1.4	1.1	1.0
4	Idle	6.0	1.8	1.3	1.2	1.0
8	"	5.4	1.7	1.4	1.2	1.0
12	"	5.4	1.6	1.3	1.3	1.1
16	"	5.7	1.7	1.3	1.2	1.0
		5.6	1.7	1.3	1.2	1.0
17	Idle-Acceleration	6.7	2.2	1.9	1.4	1.1
20	" "	6.2	2.0	1.9	1.2	1.1
22	" "	6.4	2.0	1.8	1.1	1.2
23	" "	6.8	2.1	1.9	1.1	1.2
		6.5	2.1	1.9	1.2	1.2
18	Deceleration	5.3	1.6	1.3	1.3	1.0
19	"	5.0	1.6	1.4	1.2	0.9
21	"	5.1	1.7	1.1	1.0	1.0
24	"	5.4	1.6	1.4	0.9	1.0
		5.2	1.6	1.3	1.1	1.0

TABLE 87A. VEHICLE ODOR EVALUATION RESULTS RECOMMENDED TREATMENT LEVEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: February 24, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-91-F

Run No.	Operating Conditions	"D" Diesel Composite Responses 4	5	6	7	Avg
1	30 mph at 40 hp		6	4		5.4
2	40 mph at 40 hp	2	2	5	1	5.5
3	20 mph at 40 hp	1	9			4.9
4	Idle		3	4	3	6.0
5	20 mph at 40 hp		9	1		5.1
6	30 mph at 40 hp		7	3		5.3
7	40 mph at 40 hp		7	2	1	5.4
8	Idle		6	4		5.4
9	40 mph at 40 hp		3	4	3	6.0
10	20 mph at 40 hp		8	2		5.2
11	30 mph at 40 hp		2	7	1	5.9
12	Idle		6	4		5.4
13	40 mph at 40 hp		3	6	1	5.8
14	30 mph at 40 hp		6	4		5.4
15	20 mph at 40 hp		6	4		5.4
16	Idle		3	7		5.7
17	Idle-Acceleration			3	7	6.7
18	Deceleration		7	3		5.3
19	Deceleration	2	6	2		5.0
20	Idle-Acceleration			8	2	6.2
21	Deceleration		9	1		5.1
22	Idle-Acceleration			6	4	6.4
23	Idle-Acceleration			2	8	6.8
24	Deceleration		6	4		5.4

TABLE 87B. VEHICLE ODOR EVALUATION RESULTS RECOMMENDED TREATMENT LEVEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: February 24, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-91-F

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	30 mph at 40 hp	6	4		1.4
2	40 mph at 40 hp	8	2		1.2
3	20 mph at 40 hp	8	2		1.2
4	Idle	2	8		1.8
5	20 mph at 40 hp	7	3		1.3
6	30 mph at 40 hp	4	6		1.6
7	40 mph at 40 hp	6	4		1.4
8	Idle	3	7		1.7
9	40 mph at 40 hp	1	9		1.9
10	20 mph at 40 hp	6	4		1.4
11	30 mph at 40 hp	3	7		1.7
12	Idle	4	6		1.6
13	40 mph at 40 hp	1	9		1.9
14	30 mph at 40 hp	3	7		1.7
15	20 mph at 40 hp	4	6		1.6
16	Idle	3	7		1.7
17	Idle-Acceleration		8	2	2.2
18	Deceleration	4	6		1.6
19	Deceleration	4	6		1.6
20	Idle-Acceleration		10		2.0
21	Deceleration	3	7		1.7
22	Idle-Acceleration	1	8	1	2.0
23	Idle-Acceleration		9	1	2.1
24	Deceleration	4	6		1.6

TABLE 87C. VEHICLE ODOR EVALUATION RESULTS RECOMMENDED TREATMENT LEVEL

("O" Oily Standard)

Vehicle: Bus 676
Date: February 24, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-91-F

Run No.	Operating Conditions	"O" Oily Responses 0	1	2	Avg
1	30 mph at 40 hp		9	1	1.1
2	40 mph at 40 hp		8	2	1.2
3	20 mph at 40 hp		10		1.0
4	Idle		7	3	1.3
5	20 mph at 40 hp		9	1	1.1
6	30 mph at 40 hp		8	2	1.2
7	40 mph at 40 hp		7	3	1.3
8	Idle		6	4	1.4
9	40 mph at 40 hp	1	3	6	1.5
10	20 mph at 40 hp		8	2	1.2
11	30 mph at 40 hp		6	4	1.4
12	Idle		7	3	1.3
13	40 mph at 40 hp	1	3	6	1.5
14	30 mph at 40 hp		8	2	1.2
15	20 mph at 40 hp		8	2	1.2
16	Idle		7	3	1.3
17	Idle-Acceleration		1	9	1.9
18	Deceleration		7	3	1.3
19	Deceleration		6	4	1.4
20	Idle-Acceleration		1	9	1.9
21	Deceleration		9	1	1.1
22	Idle-Acceleration		2	8	1.8
23	Idle-Acceleration		1	9	1.9
24	Deceleration		6	4	1.4

TABLE 87E. VEHICLE ODOR EVALUATION RESULTS RECOMMENDED TREATMENT LEVEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: February 24, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-91-F

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	30 mph at 40 hp		10		1.0
2	40 mph at 40 hp		10		1.0
3	20 mph at 40 hp		10		1.0
4	Idle		10		1.0
5	20 mph at 40 hp	2	8		0.8
6	30 mph at 40 hp		10		1.0
7	40 mph at 40 hp	1	9		0.9
8	Idle		10		1.0
9	40 mph at 40 hp		10		1.0
10	20 mph at 40 hp		10		1.0
11	30 mph at 40 hp		10		1.0
12	Idle		9	1	1.1
13	40 mph at 40 hp		9	1	1.1
14	30 mph at 40 hp		10		1.0
15	20 mph at 40 hp		10		1.0
16	Idle		10		1.0
17	Idle-Acceleration		9	1	1.1
18	Deceleration		10		1.0
19	Deceleration	1	9		0.9
20	Idle-Acceleration		9	1	1.1
21	Deceleration		10		1.0
22	Idle-Acceleration		8	2	1.2
23	Idle-Acceleration		8	2	1.2
24	Deceleration	1	8	1	1.0

TABLE 87D. VEHICLE ODOR EVALUATION RESULTS RECOMMENDED TREATMENT LEVEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: February 24, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-91-F

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	30 mph at 40 hp		10		1.0
2	40 mph at 40 hp		9	1	1.1
3	20 mph at 40 hp		10		1.0
4	Idle		8	2	1.2
5	20 mph at 40 hp		9	1	1.1
6	30 mph at 40 hp		9	1	1.1
7	40 mph at 40 hp	1	7	2	1.1
8	Idle		8	2	1.2
9	40 mph at 40 hp		9	1	1.1
10	20 mph at 40 hp	1	9		0.9
11	30 mph at 40 hp	1	9		0.9
12	Idle		7	3	1.3
13	40 mph at 40 hp		9	1	1.1
14	30 mph at 40 hp		10		1.0
15	20 mph at 40 hp		9	1	1.1
16	Idle		8	2	1.2
17	Idle-Acceleration		6	4	1.4
18	Deceleration		7	3	1.3
19	Deceleration		8	2	1.2
20	Idle-Acceleration		8	2	1.2
21	Deceleration		10		1.0
22	Idle-Acceleration		9	1	1.1
23	Idle-Acceleration		9	1	1.1
24	Deceleration	1	9		0.9

TABLE 88. VEHICLE ODOR EVALUATION SUMMARY TWICE RECOMMENDED TREATMENT LEVEL

Vehicle: Bus 676
Date: February 25, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-92-F

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	5.0	1.4	1.0	1.0	0.8
5	" "	4.9	1.1	1.1	1.0	0.8
10	" "	4.9	1.1	1.2	1.1	0.8
15	" "	5.8	1.6	1.6	1.3	1.1
		5.2	1.3	1.2	1.1	0.9
1	30 mph at 40 hp	4.4	1.0	1.0	1.0	0.7
6	" "	5.7	1.4	1.1	1.1	0.8
11	" "	5.8	1.4	1.4	1.2	0.8
14	" "	5.8	1.6	1.2	1.3	0.8
		5.4	1.4	1.2	1.2	0.8
2	40 mph at 40 hp	4.8	1.0	1.0	1.0	0.8
7	" "	5.7	1.4	1.4	1.2	0.8
9	" "	5.7	1.2	1.3	1.1	0.8
13	" "	5.9	1.4	1.4	1.2	0.8
		5.5	1.3	1.3	1.1	0.8
4	Idle	5.6	1.6	1.2	1.1	0.9
8	"	6.0	1.6	1.6	1.4	0.8
12	"	5.7	1.6	1.3	1.3	0.8
16	"	6.0	1.8	1.4	1.2	0.9
		5.8	1.7	1.4	1.3	0.9
17	Idle-Acceleration	6.6	1.9	1.6	1.4	1.1
20	" "	6.3	2.0	2.1	1.2	1.1
22	" "	6.7	2.1	1.9	1.1	1.0
23	" "	6.6	2.0	1.8	1.1	1.1
		6.6	2.0	1.9	1.2	1.1
18	Deceleration	5.1	1.2	1.3	1.0	0.7
19	"	4.9	1.4	1.3	1.0	0.9
21	"	4.8	1.3	1.2	1.2	0.7
24	"	5.2	1.4	1.4	1.0	0.7
		5.0	1.4	1.3	1.1	0.8

TABLE 88A. VEHICLE ODOR EVALUATION RESULTS TWICE RECOMMENDED TREATMENT LEVEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: February 25, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-92-F

Run	Operating	"D" Diesel Composite Responses				
No.	Conditions	4	5	6	7	Avg
1	30 mph at 40 hp	6	4			4.4
2	40 mph at 40 hp	2	8			4.8
3	20 mph at 40 hp	2	6	2		5.0
4	Idle		4	6		5.6
5	20 mph at 40 hp	2	7	1		4.9
6	30 mph at 40 hp		3	7		5.7
7	40 mph at 40 hp		3	7		5.7
8	Idle			10		6.0
9	40 mph at 40 hp		3	7		5.7
10	20 mph at 40 hp	2	7	1		4.9
11	30 mph at 40 hp		3	6	1	5.8
12	Idle		3	7		5.7
13	40 mph at 40 hp		2	7	1	5.9
14	30 mph at 40 hp		2	8		5.8
15	20 mph at 40 hp		3	6	1	5.8
16	Idle			10		6.0
17	Idle-Acceleration			4	6	6.6
18	Deceleration		9	1		5.1
19	Deceleration	3	5	2		4.9
20	Idle-Acceleration			7	3	6.3
21	Deceleration	5	2	3		4.8
22	Idle-Acceleration			3	7	6.7
23	Idle-Acceleration			4	6	6.6
24	Deceleration	1	6	3		5.2

TABLE 88B. VEHICLE ODOR EVALUATION RESULTS TWICE RECOMMENDED TREATMENT LEVEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: February 25, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-92-F

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	30 mph at 40 hp	10			1.0
2	40 mph at 40 hp	10			1.0
3	20 mph at 40 hp	6	4		1.4
4	Idle	4	6		1.6
5	20 mph at 40 hp	9	1		1.1
6	30 mph at 40 hp	6	4		1.4
7	40 mph at 40 hp	6	4		1.4
8	Idle	4	6		1.6
9	40 mph at 40 hp	8	2		1.2
10	20 mph at 40 hp	9	1		1.1
11	30 mph at 40 hp	6	4		1.4
12	Idle	4	6		1.6
13	40 mph at 40 hp	6	4		1.4
14	30 mph at 40 hp	4	6		1.6
15	20 mph at 40 hp	4	6		1.6
16	Idle	2	8		1.8
17	Idle-Acceleration	1	9		1.9
18	Deceleration	8	2		1.2
19	Deceleration	6	4		1.4
20	Idle-Acceleration		10		2.0
21	Deceleration	7	3		1.3
22	Idle-Acceleration		9	1	2.1
23	Idle-Acceleration		10		2.0
24	Deceleration	6	4		1.4

TABLE 88C. VEHICLE ODOR EVALUATION RESULTS TWICE RECOMMENDED TREATMENT LEVEL

("O" Oily Standard)

Vehicle: Bus 676
Date: February 25, 1969

Operating Conditions: See Tables 2 through 5
Fuel: EM-92-F

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Avg
1	30 mph at 40 hp	10			1.0
2	40 mph at 40 hp	10			1.0
3	20 mph at 40 hp	10			1.0
4	Idle	8	2		1.2
5	20 mph at 40 hp	9	1		1.1
6	30 mph at 40 hp	9	1		1.1
7	40 mph at 40 hp	6	4		1.4
8	Idle	4	6		1.6
9	40 mph at 40 hp	7	3		1.3
10	20 mph at 40 hp	8	2		1.2
11	30 mph at 40 hp	6	4		1.4
12	Idle	7	3		1.3
13	40 mph at 40 hp	6	4		1.4
14	30 mph at 40 hp	8	2		1.2
15	20 mph at 40 hp	4	6		1.6
16	Idle	6	4		1.4
17	Idle-Acceleration	4	6		1.6
18	Deceleration	7	3		1.3
19	Deceleration	7	3		1.3
20	Idle-Acceleration	2	5	3	2.1
21	Deceleration	8	2		1.2
22	Idle-Acceleration	2	7	1	1.9
23	Idle-Acceleration	3	6	1	1.8
24	Deceleration	6	4		1.4

TABLE 88D. VEHICLE ODOR EVALUATION RESULTS TWICE RECOMMENDED TREATMENT LEVEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: February 25, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-92-F

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	30 mph at 40 hp		10		1.0
2	40 mph at 40 hp		10		1.0
3	20 mph at 40 hp		10		1.0
4	Idle		9	1	1.1
5	20 mph at 40 hp		10		1.0
6	30 mph at 40 hp		9	1	1.1
7	40 mph at 40 hp		8	2	1.2
8	Idle		6	4	1.4
9	40 mph at 40 hp		9	1	1.1
10	20 mph at 40 hp		9	1	1.1
11	30 mph at 40 hp		8	2	1.2
12	Idle		7	3	1.3
13	40 mph at 40 hp		8	2	1.2
14	30 mph at 40 hp		7	3	1.3
15	20 mph at 40 hp		7	3	1.3
16	Idle		8	2	1.2
17	Idle-Acceleration		6	4	1.4
18	Deceleration		10		1.0
19	Deceleration		10		1.0
20	Idle-Acceleration	1	6	3	1.2
21	Deceleration		8	2	1.2
22	Idle-Acceleration	1	7	2	1.1
23	Idle-Acceleration		9	1	1.1
24	Deceleration		10		1.0

TABLE 88E. VEHICLE ODOR EVALUATION RESULTS TWICE RECOMMENDED TREATMENT LEVEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: February 25, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-92-F

Run No.	Operating Conditions	"P" Pungent Responses			
		0	1	2	Avg
1	30 mph at 40 hp	3	7		0.7
2	40 mph at 40 hp	2	8		0.8
3	20 mph at 40 hp	2	8		0.8
4	Idle	1	9		0.9
5	20 mph at 40 hp	3	7		0.7
6	30 mph at 40 hp	2	8		0.8
7	40 mph at 40 hp	2	8		0.8
8	Idle	2	8		0.8
9	40 mph at 40 hp	2	8		0.8
10	20 mph at 40 hp	2	8		0.8
11	30 mph at 40 hp	2	8		0.8
12	Idle	2	8		0.8
13	40 mph at 40 hp	2	8		0.8
14	30 mph at 40 hp	2	8		0.8
15	20 mph at 40 hp		9	1	1.1
16	Idle	1	9		0.9
17	Idle-Acceleration		9	1	1.1
18	Deceleration	3	7		0.7
19	Deceleration	1	9		0.9
20	Idle-Acceleration		9	1	1.1
21	Deceleration	3	7		0.7
22	Idle-Acceleration		10		1.0
23	Idle-Acceleration		9	1	1.1
24	Deceleration	3	7		0.7

TABLE 89. VEHICLE ODOR EVALUATION SUMMARY THREE TIMES RECOMMENDED TREATMENT LEVEL

Vehicle: Bus 676
Date: February 26, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-93-F

Run No.	Operating Conditions	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	4.7	1.3	1.1	1.0	0.9
5	" "	4.8	1.3	1.1	1.0	1.0
10	" "	5.1	1.3	1.3	1.1	0.9
15	" "	5.6	1.8	1.6	1.2	0.8
		5.1	1.4	1.3	1.1	0.9
1	30 mph at 40 hp	4.6	1.3	1.1	1.0	0.8
6	" "	5.2	1.7	1.2	1.0	1.0
11	" "	4.9	1.1	1.2	1.0	0.9
14	" "	5.6	1.4	1.3	1.2	0.8
		5.1	1.4	1.2	1.1	0.9
2	40 mph at 40 hp	5.0	1.4	1.1	1.0	1.0
7	" "	5.4	1.7	1.4	1.0	1.0
9	" "	4.5	1.0	1.3	1.0	0.8
13	" "	4.9	1.2	1.2	1.1	0.7
		5.0	1.3	1.3	1.0	0.9
4	Idle	5.2	1.6	1.1	1.1	1.0
8	"	5.3	1.8	1.6	1.1	0.9
12	"	5.3	1.5	1.7	1.0	0.7
16	"	5.8	1.9	1.4	1.1	1.1
		5.4	1.7	1.5	1.1	0.9
17	Idle-Acceleration	6.2	1.8	1.9	1.1	1.2
20	" "	6.0	1.8	1.8	1.4	1.2
22	" "	6.2	1.8	1.9	1.6	1.3
23	" "	6.6	1.9	2.1	1.3	1.2
		6.3	1.8	1.9	1.3	1.2
18	Deceleration	4.7	1.2	1.2	1.0	0.6
19	"	4.3	1.0	1.1	1.2	0.7
21	"	4.8	1.3	1.0	0.9	0.9
24	"	4.8	1.3	1.9	1.0	0.8
		4.7	1.2	1.3	1.0	0.8

TABLE 89A. VEHICLE ODOR EVALUATION RESULTS THREE TIMES RECOMMENDED TREATMENT LEVEL

("D" Diesel Composite Results)

Vehicle: Bus 676
Date: February 26, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-93-F

Run No.	Operating Conditions	"D" Diesel Composite Responses					
		3	4	5	6	7	Avg
1	30 mph at 40 hp		4	6			4.6
2	40 mph at 40 hp		1	8	1		5.0
3	20 mph at 40 hp		3	7			4.7
4	Idle			8	2		5.2
5	20 mph at 40 hp		3	6	1		4.8
6	30 mph at 40 hp		1	6	3		5.2
7	40 mph at 40 hp			6	4		5.4
8	Idle			7	3		5.3
9	40 mph at 40 hp		6	3	1		4.5
10	20 mph at 40 hp		2	5	3		5.1
11	30 mph at 40 hp		2	7	1		4.9
12	Idle		1	5	4		5.3
13	40 mph at 40 hp		1	9			4.9
14	30 mph at 40 hp			4	6		5.6
15	20 mph at 40 hp			4	6		5.6
16	Idle			2	8		5.8
17	Idle-Acceleration				8	2	6.2
18	Deceleration		3	7			4.7
19	Deceleration		7	3			4.3
20	Idle-Acceleration			2	6	2	6.0
21	Deceleration	1	2	5	2		4.8
22	Idle-Acceleration			1	6	3	6.2
23	Idle-Acceleration				4	6	6.6
24	Deceleration		2	8			4.8

TABLE 89B. VEHICLE ODOR EVALUATION RESULTS THREE TIMES RECOMMENDED TREATMENT LEVEL

("B" Burnt-Smoky Standard)

Vehicle: Bus 676
Date: February 26, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-93-F

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 0	1	2	3	Avg
1	30 mph at 40 hp		7	3		1.3
2	40 mph at 40 hp		6	4		1.4
3	20 mph at 40 hp		7	3		1.3
4	Idle		4	6		1.6
5	20 mph at 40 hp		7	3		1.3
6	30 mph at 40 hp		3	7		1.7
7	40 mph at 40 hp		3	7		1.7
8	Idle		3	6	1	1.8
9	40 mph at 40 hp		10			1.0
10	20 mph at 40 hp		7	3		1.3
11	30 mph at 40 hp		9	1		1.1
12	Idle		6	3	1	1.5
13	40 mph at 40 hp		8	2		1.2
14	30 mph at 40 hp		6	4		1.4
15	20 mph at 40 hp		2	8		1.8
16	Idle		1	9		1.9
17	Idle-Acceleration		2	8		1.8
18	Deceleration		8	2		1.2
19	Deceleration	1	8	1		1.0
20	Idle-Acceleration		2	8		1.8
21	Deceleration		7	3		1.3
22	Idle-Acceleration		2	8		1.8
23	Idle-Acceleration		1	9		1.9
24	Deceleration		7	3		1.3

TABLE 89C. VEHICLE ODOR EVALUATION RESULTS THREE TIMES RECOMMENDED TREATMENT LEVEL

("O" Oily Standard)

Vehicle: Bus 676
Date: February 26, 1969

Operating Conditions: See Tables 2 through 5
Fuel: EM-93-F

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Avg
1	30 mph at 40 hp	9	1		1.1
2	40 mph at 40 hp	9	1		1.1
3	20 mph at 40 hp	9	1		1.1
4	Idle	9	1		1.1
5	20 mph at 40 hp	9	1		1.1
6	30 mph at 40 hp	8	2		1.2
7	40 mph at 40 hp	6	4		1.4
8	Idle	4	6		1.6
9	40 mph at 40 hp	7	3		1.3
10	20 mph at 40 hp	7	3		1.3
11	30 mph at 40 hp	8	2		1.2
12	Idle	3	7		1.7
13	40 mph at 40 hp	8	2		1.2
14	30 mph at 40 hp	7	3		1.3
15	20 mph at 40 hp	4	6		1.6
16	Idle	6	4		1.4
17	Idle-Acceleration	2	7	1	1.9
18	Deceleration	8	2		1.2
19	Deceleration	9	1		1.1
20	Idle-Acceleration	2	8		1.8
21	Deceleration	10			1.0
22	Idle-Acceleration	2	7	1	1.9
23	Idle-Acceleration		9	1	2.1
24	Deceleration	1	9		1.9

TABLE 89D. VEHICLE ODOR EVALUATION RESULTS THREE TIMES RECOMMENDED TREATMENT LEVEL

("A" Aromatic Standard)

Vehicle: Bus 676
Date: February 26, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-93-F

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Avg
1	30 mph at 40 hp		10		1.0
2	40 mph at 40 hp		10		1.0
3	20 mph at 40 hp		10		1.0
4	Idle		9	1	1.1
5	20 mph at 40 hp		10		1.0
6	30 mph at 40 hp		10		1.0
7	40 mph at 40 hp		10		1.0
8	Idle	1	7	2	1.1
9	40 mph at 40 hp		10		1.0
10	20 mph at 40 hp		9	1	1.1
11	30 mph at 40 hp	1	8	1	1.0
12	Idle		10		1.0
13	40 mph at 40 hp		9	1	1.1
14	30 mph at 40 hp		8	2	1.2
15	20 mph at 40 hp		8	2	1.2
16	Idle		9	1	1.1
17	Idle-Acceleration	1	7	2	1.1
18	Deceleration		10		1.0
19	Deceleration		8	2	1.2
20	Idle-Acceleration		6	4	1.4
21	Deceleration	1	9		0.9
22	Idle-Acceleration		4	6	1.6
23	Idle-Acceleration		7	3	1.3
24	Deceleration		10		1.0

TABLE 89E. VEHICLE ODOR EVALUATION RESULTS THREE TIMES RECOMMENDED TREATMENT LEVEL

("P" Pungent Standard)

Vehicle: Bus 676
Date: February 26, 1969

Operating Conditions: See Tables 2 through 5

Fuel: EM-93-F

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	30 mph at 40 hp	2	8		0.8
2	40 mph at 40 hp		10		1.0
3	20 mph at 40 hp	1	9		0.9
4	Idle		10		1.0
5	20 mph at 40 hp		10		1.0
6	30 mph at 40 hp		10		1.0
7	40 mph at 40 hp		10		1.0
8	Idle	1	9		0.9
9	40 mph at 40 hp	2	8		0.8
10	20 mph at 40 hp	1	9		0.9
11	30 mph at 40 hp	1	9		0.9
12	Idle	3	7		0.7
13	40 mph at 40 hp	3	7		0.7
14	30 mph at 40 hp	2	8		0.8
15	20 mph at 40 hp	2	8		0.8
16	Idle		9	1	1.1
17	Idle-Acceleration		8	2	1.2
18	Deceleration	4	6		0.6
19	Deceleration	3	7		0.7
20	Idle-Acceleration		8	2	1.2
21	Deceleration	1	9		0.9
22	Idle-Acceleration		7	3	1.3
23	Idle-Acceleration		8	2	1.2
24	Deceleration	2	8		0.8

TABLE 90. WEEKLY ODOR ADDITIVE, FUEL AND ENGINE LUBE OIL CONSUMPTION (ADDITIVE FLEET)

Test Week	Miles Operated	Concentrate Additive (ml)	Fuel (gal)	Oil (qt)	Days Operated	Miles Operated	Additive (ml)	Fuel (gal)	Oil (qt)	Days Operated	Miles Operated	Additive (ml)	Fuel (gal)	Oil (qt)	Days Operated
		Bus No. 676						Bus No. 678					Bus No. 680		
1	708	83.7	177	5.0	5	194	25.1	53	1.5	2	318	67.3	142	1.4	4
2	1,041	131.5	278	7.4	5	750	101.8	215	6.0	5	835	103.0	218	3.7	5
3	811	98.0	207	5.5	5	680	101.2	214	4.6	5	952	123.5	272	4.2	5
4	500	62.5	132	3.4	5	562	71.8	152	3.8	5	636	83.8	177	2.8	5
5	1,106	136.2	288	7.6	5	583	78.2	165	3.3	4	768	81.4	172	2.9	5
6	520	72.9	154	3.6	3	488	73.4	155	3.3	3	1,072	132.4	280	4.0	5
7	586	64.4	136	2.9	4	683	91.8	194	3.9	5	897	109.7	232	3.3	5
8	858	106.8	226	4.2	5	815	106.0	224	4.6	5	852	105.0	221	3.2	5
9	1,024	126.8	268	5.0	5	647	81.0	171	3.6	5	1,268	130.0	275	4.7	5
10	976	114.0	241	4.8	5	409	52.2	110	2.3	4	666	76.2	161	3.3	5
11	1,017	109.8	232	5.0	5	583	81.4	172	3.3	5	618	74.8	158	3.0	5
12	1,043	109.2	231	5.1	5	448	53.1	114	2.0	4	804*	95.4	202	4.0	3
13*	561	63.0	133	2.8	3	800	94.3	199	3.6	5	714	70.0	148	3.5	4
14	847	90.0	190	4.2	5	377*	43.0	91	1.7	3	434	51.6	109	2.2	5
15	780	79.5	168	3.8	4	458	72.0	152	2.0	4	774	83.2	176	3.9	5
16	1,099	116.4	246	4.2	5	850	75.7	160	4.1	5	901	94.0	205	4.5	6
17	1,170	121.2	256	4.5	5	714	78.2	165	3.5	5	442	50.6	107	2.2	4
18	1,254	139.2	294	4.8	6	1,108	118.2	250	5.4	6	435	55.8	118	1.5	4
19	300	36.0	76	1.1	3	502	54.9	116	2.4	4	539	73.3	155	1.8	5
20	346	41.2	87	1.4	4	223	32.6	69	1.0	4	622	74.7	156	2.1	5
21	395	48.3	102	1.6	5	407	50.2	106	1.8	5	499	66.5	141	1.7	5
22	410	43.0	91	1.7	5	397	52.5	113	1.8	5	516	57.2	121	1.7	5
23	475	55.0	116	1.9	5	478	52.1	110	2.1	5	583	71.5	151	3.6	5
24	446	48.3	102	1.8	5	406	54.5	115	1.8	5	327	43.5	92	2.0	3
25	399	47.8	101	2.4	5	442	51.2	108	3.0	5	581	75.2	159	3.6	5
26	495	54.0	112	3.0	5	616	76.8	162	4.1	6	450	61.5	130	0.8	5
27†	163	20.4	43	1.0	3	319	40.7	86	2.1	5	†Final Inspection this week.				
28						120†	13.7	29	0.8	2					
Total	19,330	2219.1	4687	99.7	125	15,059	1877.6	3970	83.4	126	17,503	2111.1	4478	75.6	123

	Hubometer at Start	Hubometer at End	Miles Traveled
Bus No. 676	264,825	284,155	19,330
Bus No. 678	267,099	282,158	15,059
Bus No. 680	257,951	275,454	17,503

---

*Interim inspection.

†Final inspection.

TABLE 91. WEEKLY FUEL AND ENGINE LUBE OIL CONSUMPTION (CONTROL FLEET)

Week No.	Miles Operated	Fuel (gal)	Oil (qt)	Days Operated	Miles Operated	Fuel (gal)	Oil (qt)	Days Operated	Miles Operated	Fuel (gal)	Oil (qt)	Days Operated
	Bus No. 685				Bus No. 686				Bus No. 688			
1	542	171	6.8	5	862	269	5.5	6	485	142	3.7	5
2	627	198	7.0	5	537	167	3.3	5	431	139	3.3	5
3	912	291	10.2	6	791	246	5.0	5	529	155	4.0	5
4	522	165	5.9	5	660	206	4.2	5	545	160	4.1	5
5	781	226	9.5	5	787	234	3.3	5	516	149	3.5	5
6	825	239	10.0	5	492	146	2.1	5	481	140	3.3	5
7	702	203	8.6	5	969	288	3.4	6	422	122	2.9	5
8	754	219	9.2	5	609	181	2.6	5	781	227	5.4	6
9	433	108	3.1	4	499	140	3.7	5	389	95	2.9	4
10	515	128	3.7	5	714	200	5.2	5	577	142	4.3	5
11	747	186	5.4	5	663	185	4.9	5	535	131	4.0	5
12	901	225	6.5	6	809	216	5.9	5	367	90	2.8	4
13	342	85	3.3	4	443	123	3.3	4	408	100	3.1	5
14	243	62	1.7	3	387	95	2.8	4	942	219	7.5	6
15	816	207	5.8	5	691	169	4.9	5	433	101	3.5	5
16	445	113	3.1	5	803	198	5.7	6	611	142	4.9	5
17	615	156	4.4	5	659	161	4.7	5	501	117	4.0	5
18	332	85	1.4	4	419	104	3.8	5	815	216	4.1	6
19	389	99	1.6	5	462	125	4.2	5	444	130	2.3	5
20	427	109	1.8	5	209	52	1.9	3	191	51	1.0	3
21	299	77	1.2	4	342	85	3.1	4	400	103	2.0	5
22	503	129	2.1	5	300	75	2.8	3	320	85	1.6	3
23	167	42	0.7	3	511	132	3.5	5	388	100	3.7	4
24	396	100	1.8	5	496	128	3.4	5	572	147	5.4	5
25	713	180	3.1	5	303	78	2.1	4	540	139	5.1	5
26	697	176	3.1	5	249	65	1.8	3	620	160	5.8	5
Total	14,645	3979	121.0	124	14,666	4068	97.1	123	13,243	3502	98.2	126

	Hubometer at Start	Hubometer at End	Miles Traveled
Bus No. 685	298,148	312,793	14,645
Bus No. 686	263,598	278,264	14,666
Bus No. 688	292,103	305,346	13,243

TABLE 92. SUMMARY OF ADDITIVE, FUEL, AND LUBE OIL CONSUMPTION RATES (ADDITIVE AND CONTROL FLEETS)

	Additive Test Fleet			Nonadditive Fleet		
	Bus No. 676	Bus No. 678	Bus No. 680	Bus No. 685	Bus No. 686	Bus No. 688
Mileage Data						
Miles/Day	154.6	119.5	142.3	118.1	119.2	105.1
Miles/Week	773.2	597.5	693.2	590.5	595.9	525.5
Miles/Month	3221.7	2509.8	2842.1	2440.8	2444.3	2207.1
Fuel Consumption						
Miles/Gal	4.124	3.793	3.908	3.680	3.605	3.781
Gal/Week	187.48	157.54	188.03	163.70	165.35	138.80
Gal/Month	781.17	661.66	746.33	666.10	678.00	583.30
Oil Consumption						
Miles/Qt	193.8	180.5	231.5	121.0	151.0	134.8
Qt/Month	16.6	13.9	12.6	20.1	16.2	16.3
Additive Consumption						
Ml/Mile	0.1148	0.1245	0.1206	----	----	----
Mile/Qt	8257.9	7604.5	7845.3	----	----	----
Gal/Month	0.0976	0.0826	0.0927	----	----	----
Mile/Lb	4120.5	3793.2	3921.8	----	----	----
Lb/Week	0.1875	0.1575	0.1814	----	----	----
Lb/Month	0.7816	0.6616	0.7455	----	----	----
Miles Operated	19,330	15,059	17,503	14,645	14,666	13,243
No. of Days	125	126	123	124	123	126
No. of Weeks	25.0	25.2	24.6	24.8	24.6	25.2
No. of Months	6	6	6	6	6	6

APPENDIX B

RESULTS OF SCREENING AND FLEET TEST OF A DIESEL EXHAUST CATALYTIC MUFFLER

TABLE 1. DESCRIPTION OF VEHICLES AND ENGINES USED DURING CATALYTIC MUFFLER SCREENING

Vehicle Data:		
Bus Number	678	680*
Manufacturer	General Motors Truck & Coach	General Motors Truck & Coach
Model	TDH 4519	TDH 4519
Source	S. A. Transit	S. A. Transit
Air Conditioned	Yes	Yes
Year	1963	1963
Engine Data:		
Manufacturer	Detroit Diesel General Motors	Detroit Diesel General Motors
Engine Number	6V-71E	6V-71E
Cycles	2	2
Horsepower Rating at 2100 rpm	200	200
Cylinders/Arrangement	6/V	6/V
Compression Ratio	17:1	17:1
Displacement, cubic inches	425.6	425.6
Bore and Stroke, inches	4-1/4 × 5	4-1/4 × 5
Number of Exhaust Valves	2	2
Type Injectors	Unit	Unit
Injector Size	60S	60S
Engine Maintenance:		
Total Miles (Start of Test)	260,207	250,108
Miles since Injector Change	195,327	176,000
Miles since Major Overhaul	Original	Original
Drive Line Data:		
Transmission	Allison V-H	Allison V-H
Number of Forward Speeds	2	2
Rear Axle	Rockwell Standard	Rockwell Standard
Rear Axle Ratio	4.714:1	4.714:1
Number of Drive Axles	1	1
Tire Size	10.00 × 20	10.00 × 20

---

*Bus 680 used for routine mileage accumulation only. Odor, smoke and emissions evaluations with catalytic mufflers obtained with Bus 678.

TABLE 2. ODOR EVALUATION CONDITIONS EMPLOYED DURING EVALUATION OF CATALYTIC MUFFLERS

Vehicle Data:	GM Truck and Coach Model TDH-45 19 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. On vehicle with air-conditioning rack compensator, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is not operated.
Sampling Data:	Constant sample flow at 100:1 dilution level.
Inertia:	Full inertia simulation via SwRI system.

OPERATING CONDITIONS

	Type Operation	Vehicle Speed, mph	Vehicle Load, hp	For Details, Refer to:
I.	Constant Speed	20	40	Table 3
II.	Constant Speed	40	40	Table 3
III.	Constant Speed-Idle	--	--	Table 4
IV.	Idle-Acceleration	0-20	0	Table 5
V.	Constant Speed-Deceleration	40-0	40 hp at 40 mph	Table 6

TABLE 3. CONSTANT SPEED DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.

Vehicle Speeds and Loads: The following are to be run with the transmission in the drive range under full inertia simulation, air conditioning "off."

Vehicle Speed, mph	Engine Speed, rpm	Vehicle Load, hp	Power Level, approx
20	890	40	Near maximum
40	1590	40	2/3 rack

Procedure:

(1) Operate at given stable speed and load for 15 sec.

(2) Turn "on" 45-sec panel warning light, turn dilution system to "auto" control, and continue stable operation.

(3) Ring bell for panel to begin odor evaluation and maintain stable operation.

(4) Panel turns "off" light when evaluation is complete. The evaluation requires 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(5) When light goes "off," turn dilution system to "man" control, and decelerate to idle. Permit rear tires to rotate and cool.

(6) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts when light goes "out.")

Run Time: Approximately 3 min, with 5-min rest - 8 min.

TABLE 4. ENGINE IDLE DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three complete runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.

Vehicle Speed and Load: Operate at 30 mph and 40 hp for 1 min, followed by closed-rack deceleration to downshift (17 mph), and allow engine to idle. (Air conditioning off and with inertia simulation.)

Procedure:

(1) Operate at 30 mph and 40 hp, stable.

(2) Turn "on" panel warning light and maintain stable operation.

(3) After 1 min of stable sustained operation, closed-rack decelerate to downshift, and allow engine to idle.

(4) Turn dilution system to "auto" 2 sec after downshift.

(5) Ring bell to begin panel exposure 15 sec after downshift.

(6) Panel turns "off" light when evaluation is complete. The evaluation requires 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(7) When light is "off," turn dilution system to "man" control and permit rear tires to rotate and cool.

(8) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts when light goes "out.")

Run Time: Approximately 3 min, with 5-min rest - 8 min.

TABLE 5. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.

Inertia: Full inertia simulation via SwRI system.

Vehicle Speed and Load: Idle for 1 min, followed by full-rack acceleration to 20 mph with inertia only.

Procedure:

(1) Turn "on" 60-sec panel warning light, turn dilution system to "auto," and idle for 1 min, rear wheels stationary.

(2) Accelerate full rack to 20 mph under full inertia simulation.

(3) Ring bell for panel exposure 3 sec after start of acceleration.

(4) Hold 20 mph for 15 sec, turn off engine and turn dilution system to "man."

(5) Two min after turning "off" engine, start engine and allow to idle. Turn on 60-sec panel warning light and turn dilution system to "auto." Allow to idle for 1 min, rear wheels stationary.

(6) Repeat items (2) through (5) above. The original and repeat idle-acceleration constitute one run.

(7) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts when engine is turned "off.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite, and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6.5 min, with 5-min rest - 11.5 min.

TABLE 6. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.
Sample Method:	Constant sample flow at 100:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speed and Load:	Operate at stable 40 mph and 40 hp for 1 min, followed by closed-rack deceleration with full inertia simulation, air conditioning "off."
Procedure:	(1) Operate at 40 mph and 40 hp, stable. (2) Turn "on" 60-sec panel warning light, turn dilution system to "auto" and maintain stable operation. (3) After 1 min of stable sustained operation, closed-rack decelerate to downshift. (4) Ring bell for panel exposure at 23 mph. (5) On reaching downshift (17 mph), permit engine to idle and cool tires. Turn "off" light and turn dilution system to "man." (6) Two min after downshift, return to 40 mph and 40 hp condition. (7) Repeat items (2) through (5) above. The original and repeat constant speed-deceleration constitute one run. (8) Wait 5 min between runs for panel rest, tire cooling, and orifice change. (Time starts on engine downshift.) Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with only an original and a repeat exposure (sniff).
Run Time:	Approximately 7 min, with 5-min rest - 12 min.

TABLE 7. SMOKE EVALUATION CONDITIONS EMPLOYED DURING EVALUATION OF CATALYTIC MUFFLERS

Vehicle Data:	GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. On vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is not operated.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter.
Inertia:	Full inertia simulation via SwRI system.

OPERATING CONDITIONS

Type Operation	Vehicle Speed, mph	Transmission Drive Range	Vehicle Load, hp	For Details, Refer to:
A. Constant Speed	20	High	Open rack	Table 8
B. Constant Speed	25	High	Open rack	Table 8
C. Constant Speed	30	High	Open rack	Table 8
D. Constant Speed	35	High	Open rack	Table 8
E. Idle-Acceleration	0-40	--	40 hp at 30 mph	Table 9

TABLE 8. CONSTANT SPEED DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator, if used, removed.
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speeds and Loads:	The following are to be run:

Vehicle Speed, mph	Transmission Drive Range	Engine Speed, rpm approx	Power Load
20	High	900	Open rack
25	High	1000	Open rack
30	High	1200	Open rack
35	High	1400	Open rack

Procedure:

(1) Zero potentiometric recorder and 100% adjust smokemeter with engine "off" using 2 SCFM of purge air to collimating tubes.

(2) Start engine and accelerate through upshift and load vehicle back to 20 mph at open-rack maximum horsepower. On those vehicles which tend to downshift at 20 mph constant speed, operate as near 20 mph as possible. After 30 sec of stable operation, note the average maximum smokemeter reading.

(3) Release some load in the water brake dynamometer, and allow vehicle speed to increase to 25 mph. After 30 sec of stable operation, note the average maximum smokemeter reading.

(4) Using the procedure in item (3), similarly operate at 30 and 35 mph.

(5) Repeat items (1) through (4) two times.

TABLE 9. IDLE-ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	GM Truck and Coach Model 4519 city bus powered by Detroit Diesel 6V-71 engine.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator, if used, removed.
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speed and Load:	Idle for 1 min, followed by full-rack acceleration to 40 mph with inertia and initially preset dynamometer load.
Procedure:	(1) Zero potentiometric recorder and 100% adjust smokemeter with engine "off" using 2 SCFM of purge air to collimating tubes. (2) Start engine and allow to idle for one min. Note maximum smoke at start on recorder. (3) After 1 min of idle, full-rack accelerate to 40 mph against full bus inertia simulation and under the initially set load of 40 hp at 30 mph in the water brake type dynamometer. Some vehicles will not reach 40 mph with 40 hp impressed at 30 mph. Operate as far past 30 mph as reasonable and discontinue. Maximum smoke normally does not occur at these higher speeds. (4) Note the maximum smoke at the start of acceleration and at upshift. (5) Repeat items (1) through (4) above two times.

TABLE 10. VEHICLE OPERATING CONDITIONS, SAMPLING PROCEDURE AND ANALYTICAL METHODS FOR DIESEL EXHAUST EMISSIONS MEASUREMENTS

Applicability: GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.

Sample Method: Exhaust obtained direct from central stack at same point odor samples are obtained, 6 ft from vehicle tailpipe exit.

Warm-up: A minimum of three runs should be conducted prior to exhaust sampling to assure the engine and system have reached operating temperature. Air conditioning "off."

Operating Conditions: The following are to be run under full inertia simulation with the air conditioning "off."

Type Operation	Vehicle Speed, mph	Vehicle Load, hp	Engine Speed, rpm	Trans Drive Range	Power Level, approx
I. Cruise	20	40	890	High	2/3 rack
II. Cruise	40	40	1590	High	2/3 rack
III. Idle	0	0	500	Neutral	Closed rack

Operating and Sampling Procedure:

(1) Operate at Condition I, 20 mph, 40 hp until CO and CO_2 instruments indicate stable engine/vehicle operation (about 1 to 1.5 min).

(2) Begin 3-min sample period for acrolein, aldehydes/formaldehyde and SO_2 at 1 liter/min observed rate. Take duplicate 5-cc syringe sample for NO_x. Record average CO and CO_2 readings during 3-min period.

(3) After 3-min sample is obtained, allow vehicle to idle and cool tires. Remove bubblers for acrolein, aldehydes/formaldehyde and SO_2. Wash down and prepare for next samples.

(4) Operate at Condition II, 40 mph, 40 hp and repeat items (2) and (3) above.

(5) Operate at Condition III, engine idle after 1-min cruise at 30 mph and 40 hp and repeat items (2) and (3) above.

(6) Repeat items (1) through (5) above three times in above sequence.

Analytical Procedure: Analysis of the diesel exhaust samples made for the chemical constituents using the procedures listed below:

Constituent	Procedure/Method	Reference
CO	Beckman 315 nondispersive infrared 0-2200 ppm CO, 5-1/4-in. sample cell	
CO_2	Beckman 315 nondispersive infrared 0-15% CO_2, 1/8-in. sample cell	
NO_x	Modified Saltzman syringe method NO plus NO_2 as ppm NO_2	PHS Publication 999-AP-11 modified
SO_2	West and Gaeke Method	PHS Publication 999-AP-11
Acrolein	4-Hexylresorcinol method	Cohen, I. R., and Altshuller, A. P., Anal. Chem., 33, 726-33 (1961) PHS Publication 999-AP-11
Total Aldehydes	3-Methyl-2 benzothiazolone hydrazone (MBTH) method	Sawicki, E., et al., Anal. Chem., 33, 93-6 (1961) Reckner, L. R., et al., Proc. API, 45, 133, 141 (1967)
Formaldehyde	Chromatropic acid method	Altshuller, A. P., et al., Anal. Chem., 33, 621-25 (1961) PHS Publication 999-AP-11 Reckner, L. R., et al., Proc. API, 45, 133, 141 (1965)

Note: Time between runs is approximately 10 to 15 min. Total sampling and ready time is 3 to 4 hr. Total analysis time is 4 hr.

TABLE 11. CONSTANT SPEED PROCEDURE FOR MEASUREMENT OF VEHICLE MUFFLER TEMPERATURE AND PRESSURE AND ENGINE AIR BOX PRESSURE

Applicability: GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.

Measurement Method: Open U-tube mercury manometer and L&N millivolt potentiometer with chromel-alumel type K thermocouples. Measurements are obtained at the same time the odor evaluations are conducted.

Warm-up: A minimum of three complete runs should be conducted prior to measurement of pressures and temperatures to assure the engine and system have reached operating temperature.

Operating Conditions: The following are to be run with the transmission in the drive range under full inertia simulation, air conditioning "off":

Type Operation	Vehicle Speed, mph	Engine Speed, rpm	Vehicle Load, hp	Power Level, approx
I	20	890	40	Near maximum
II	40	1590	40	2/3 rack

Procedure:

(1) Operate at given stable speed and load for 15 sec.

(2) Turn "on" 45-sec odor panel warning light, turn exhaust dilution system to "auto" control, and continue stable operation.

(3) Read the pressure differential across the muffler, and then disconnect the tube leading to the inlet side of the muffler from the muffler manometer.

(4) Read the air box pressure from the air box manometer, and then the outlet muffler pressure from the muffler manometer.

(5) Disconnect the tube leading to the outlet side of the muffler and reconnect the inlet tube to the muffler manometer.

(6) Read the inlet and then the outlet muffler temperature in millivolts from the potentiometer.

(7) Read the inlet muffler pressure from the muffler manometer.

Note: The above procedure is conducted simultaneously with the evaluation of odor.

TABLE 12. ENGINE IDLE VEHICLE MUFFLER INLET AND OUTLET TEMPERATURE, AND PRESSURE AND AIR BOX PRESSURE MEASUREMENT PROCEDURES

Applicability: GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.

Measurement Method: Open U-tube mercury manometer and L&N millivolt potentiometer with chromel-alumel, type K thermocouples. Measurements are obtained at the same time the odor evaluations are conducted.

Warm-up: A minimum of three complete runs should be conducted prior to measurement of pressures and temperatures to assure the engine and system have reached operating temperature.

Operating Condition: Operate at 30 mph and 40 hp for 1 min followed by closed-rack deceleration to downshift (17 mph) and allow engine to idle. (Air conditioning "off" and with full inertia simulation.)

Procedure:

(1) Operate at 30 mph and 40 hp, stable.

(2) Turn "on" odor panel warning light and maintain stable 30-mph operation for 1 min, during which time conduct steps (3) through (7) in Table 11, Appendix B, to obtain physical measurements at this cruise condition.

(3) After 1 min of stable sustained operation, begin closed-rack decelerate to downshift and allow engine to idle.

(4) Read pressure differential across the muffler and then disconnect the tube leading to the inlet side of the muffler from the muffler manometer.

(5) Read the air box pressure from the air box manometer and then the outlet muffler pressure from the muffler manometer.

(6) Disconnect the tube leading to the outlet side of the muffler and reconnect the inlet tube to the muffler manometer.

(7) Read the inlet muffler pressure from the muffler manometer.

(8) One min after the downshift, read the muffler inlet temperature and then the muffler outlet temperature in millivolts from the potentiometer.

Note: The above procedure is conducted simultaneously with the evaluation of odor.

TABLE 13. AIR BOX PRESSURE MEASUREMENT PROCEDURE FOR VEHICLES POWERED BY TWO-CYCLE ENGINES

Applicability:	GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.
Measurement Method:	Open U-tube mercury manometer and General Radio strobotac for engine speed measurement.
Warm-up:	A minimum of three complete runs should be conducted prior to pressure measurement to assure the engine and system have reached operating temperature.
Engine Speed and Load:	Air box pressures are to be measured at 1200, 1800, and 2100 rpm with the transmission in neutral and no load applied to the engine.
Procedure:	(1) Using a strobotac to indicate speed, adjust throttle to given engine speed. (2) Record air box pressure. (3) Repeat items (1) and (2) for engine speeds of 1200, 1800, and 2100 rpm.
Run Time:	Five min for total time of about 10 min.

TABLE 14. STATISTICAL EVALUATION PROCEDURE EMPLOYED TO DETERMINE STATISTICAL DIFFERENCE OF ODOR AND EMISSIONS MEASUREMENTS OF CATALYTIC MUFFLER VS STOCK MUFFLER

Applicability: GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 E or N series, two-valve engine. Muffler under coach. For vehicles with rack compensator for air conditioning, the compensator is removed. For vehicles equipped with Jacobs retarders, the retarder is left operative.

Statistical Method: The "U" statistic test (Mann-Whitney test), which was used to make the evaluations, is described by the following expression:

$$U_s = mn + \frac{m(m+1)}{2} - T$$

where

m - number of readings in the smaller set

n - number of readings in the larger set

for

$m \neq n$, T is the sum of the relative rankings of the smaller set

$m = n$, T is the sum of the set which gives the larger relative ranking

For purposes of determining whether the catalytic muffler is statistically different from the stock muffler, it has been determined by SwRI statisticians that the "U_s" statistic should be either 0, 1, or 2, where m equals n; that is, the number of repeat measurements is the same for the catalytic and noncatalytic sets of data. Where an uneven number of data has been obtained such that m does not equal the n, the most common occurrence being m equal to 3 and n equal to 4, the statistical difference has been placed where the "U_s" statistic is equal to 0 or 1.

Procedure: (1) Given is a set of actual responses of the overall "D" diesel composite for a 20 mph, constant speed, cruise condition:

Stock	Catalytic
6.8	4.4
6.4	6.3
6.1	4.4
6.0	5.8

(2) Since the number of responses are the same for both the catalytic muffler and stock muffler, designate the catalytic muffler data as set "n" and stock muffler data as set "m."

(3) The four values of set "m" and the four values of set "n" are ranked according to the least intense response first to the most intense response in the eight position.

Relative Ranking	"D" Response
1	4.4 - Catalytic
2	4.4 - Catalytic
3	5.8 - Catalytic
4	6.0 - Stock
5	6.1 - Stock
6	6.3 - Catalytic
7	6.4 - Stock
8	6.8 - Stock

(4) Since the set "m" and "n" are of equal number, the largest sum (T) of the relative rankings will be used to compute U_s.

Set "m" (Stock)	Set "n" (Catalytic)
4	1
5	2
7	3
8	6
24	12

(5) Given is the equation for the "U_s" statistic. Evaluating this equation gives a U_s value of two. By definition of the "U" test statistic with the sets m = n - 4, a statistical difference is indicated:

$$U_s = mn + \frac{m(m+1)}{2} - T$$

$$U_s = 26 - 24$$

$$U_s = 2$$

TABLE 15. VEHICLE 678 SCHEDULE OF CATALYTIC MUFFLER CODE "Z"-1 EVALUATION AND ENGINE MAINTENANCE SUMMARY

Date	Test Time, days	Total Mileage	Test Miles	Description of Test Conducted Maintenance Performed
4/29/68	0	260,207	0	Installed Code "Z"-1 muffler
6/4/68	35	263,294	3,087	Evaluated emissions and smoke Code "Z"-1
6/5/68				Evaluated odor - Code "Z"-1
6/5/68				Installed stock muffler
6/6/68				Evaluated odor and smoke stock muffler
6/7/68				Evaluated emissions - stock muffler

End of Test

Note: No engine maintenance performed during test period.

TABLE 16. VEHICLE ODOR EVALUATION SUMMARY-- CATALYTIC MUFFLER CODE "Z"-1 INSTALLED

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3,087

Date: June 5, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No. *	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	I. Constant Speed	6.3	1.9	1.8	1.0	0.5
12	" "	7.0	2.0	1.9	1.3	1.3
17	" "	6.5	1.5	1.5	1.0	0.5
24	" "	7.3	1.9	1.9	1.3	1.5
		6.8	1.8	1.8	1.2	1.0
3	II. Constant Speed	6.5	1.9	1.6	1.4	0.5
8	" "	5.5	1.8	1.3	1.1	0.8
19	" "	7.3	2.0	2.0	1.1	1.5
22	" "	7.8	2.1	2.1	1.8	1.5
		6.8	2.0	1.8	1.4	1.1
5	III. Idle	5.9	2.0	1.3	1.0	0.4
10	"	6.3	2.0	1.3	1.8	0.8
13	"	5.3	1.1	1.1	1.1	0.1
20	"	4.8	0.8	0.8	1.3	0.3
		5.6	1.5	1.1	1.3	0.4
4	IV. Idle-Acceleration	6.8	2.0	1.9	1.3	1.0
6	" "	7.0	2.0	1.9	1.6	1.0
16	" "	8.0	2.0	2.0	1.3	2.0
23	" "	7.3	2.0	2.0	1.1	1.5
		7.3	2.0	2.0	1.3	1.4
2	V. Deceleration	5.0	1.3	1.0	1.0	0.4
9	"	5.1	1.6	1.0	1.0	0.9
14	"	5.0	1.1	1.1	1.1	0.3
21	"	5.3	1.1	1.1	1.1	0.3
		5.1	1.3	1.1	1.1	0.5

---

*Runs 2, 7, 11, and 15 were conducted without exhaust sample.

TABLE 16A. VEHICLE ODOR EVALUATION RESULTS-- "Z"-1 MUFFLER

("D" Diesel Composite Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 5, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	4	5	6	7	8	Average
1	Constant Speed				6	2		6.3
2	Deceleration			8				5.0
3	Constant Speed				6		2	6.5
4	Idle-Acceleration				2	6		6.8
5	Idle			1	7			5.9
6	Idle-Acceleration					8		7.0
7	Blank	8						0
8	Constant Speed			5	2	1		5.5
9	Deceleration			7	1			5.1
10	Idle				6	2		6.3
11	Blank	8						0
12	Constant Speed					8		7.0
13	Idle			6	2			5.3
14	Deceleration			8				5.0
15	Blank	8						0
16	Idle-Acceleration						8	8.0
17	Constant Speed			1	2	5		6.5
18	Blank	8						0
19	Constant Speed					6	2	7.3
20	Idle		2	6				4.8
21	Deceleration			6	2			5.3
22	Constant Speed					2	6	7.8
23	Idle-Acceleration					6	2	7.3
24	Constant Speed					6	2	7.3

TABLE 16B. VEHICLE ODOR EVALUATION RESULTS-- "Z"-1 MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 5, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		1	7		1.9
2	Deceleration		6	2		1.3
3	Constant Speed		2	5	1	1.9
4	Idle-Acceleration			8		2.0
5	Idle			8		2.0
6	Idle-Acceleration			8		2.0
7	Blank	8				0
8	Constant Speed		2	6		1.8
9	Deceleration		3	5		1.6
10	Idle			8		2.0
11	Blank	8				0
12	Constant Speed			8		2.0
13	Idle		7	1		1.1
14	Deceleration		7	1		1.1
15	Blank	8				0
16	Idle-Acceleration			8		2.0
17	Constant Speed		4	4		1.5
18	Blank	8				0
19	Constant Speed			8		2.0
20	Idle	2	6			0.8
21	Deceleration		7	1		1.1
22	Constant Speed			7	1	2.1
23	Idle-Acceleration			8		2.0
24	Constant Speed		1	7		1.9

TABLE 16C. VEHICLE ODOR EVALUATION RESULTS-- "Z"-1 MUFFLER

("O" Oily Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 5, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses				
		0	1	2	3	Average
1	Constant Speed		2	6		1.8
2	Deceleration		8			1.0
3	Constant Speed		3	5		1.6
4	Idle-Acceleration		1	7		1.9
5	Idle		6	2		1.3
6	Idle-Acceleration		1	7		1.9
7	Blank	8				0
8	Constant Speed		6	2		1.3
9	Deceleration		8			1.0
10	Idle		6	2		1.3
11	Blank	8				0
12	Constant Speed		1	7		1.9
13	Idle		7	1		1.1
14	Deceleration		7	1		1.1
15	Blank	8				0
16	Idle-Acceleration			8		2.0
17	Constant Speed		4	4		1.5
18	Blank	8				2.0
19	Constant Speed			8		2.0
20	Idle	2	6			0.8
21	Deceleration		7	1		1.1
22	Constant Speed			7	1	2.1
23	Idle-Acceleration			8		2.0
24	Constant Speed		1	7		1.9

TABLE 16D. VEHICLE ODOR EVALUATION RESULTS-- "Z"-1 MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 678	Date: June 5, 1968
Test Days: 35	Operating Conditions: See Table 2
Test Mileage: 3087	Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses				
		0	1	2	3	Average
1	Constant Speed		8			1.0
2	Deceleration		8			1.0
3	Constant Speed		5	3		1.4
4	Idle-Acceleration		6	2		1.3
5	Idle		8			1.0
6	Idle-Acceleration		3	5		1.6
7	Blank	8				0
8	Constant Speed		7	1		1.1
9	Deceleration		8			1.0
10	Idle		2	6		1.8
11	Blank	8				0
12	Constant Speed		6	2		1.3
13	Idle		7	1		1.1
14	Deceleration		7	1		1.1
15	Blank	8				0
16	Idle-Acceleration	1	5	1	1	1.3
17	Constant Speed	1	6	1		1.0
18	Blank	8				0
19	Constant Speed	1	5	2		1.1
20	Idle		6	2		1.3
21	Deceleration		7	1		1.1
22	Constant Speed		2	6		1.8
23	Idle-Acceleration		7	1		1.1
24	Constant Speed		6	2		1.3

TABLE 16E. VEHICLE ODOR EVALUATION RESULTS-- "Z"-1 MUFFLER

("P" Pungent Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3,087

Date: June 5, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	5	2	1	0.5
2	Deceleration	5	3		0.4
3	Constant Speed	5	2	1	0.5
4	Idle-Acceleration	1	6	1	1.0
5	Idle	5	3		0.4
6	Idle-Acceleration		8		1.0
7	Blank	8			0
8	Constant Speed	2	6		0.8
9	Deceleration	1	7		0.9
10	Idle	2	6		0.8
11	Blank	8			0
12	Constant Speed		6	2	1.3
13	Idle	7	1		0.1
14	Deceleration	6	2		0.3
15	Blank	8			0
16	Idle-Acceleration			8	2.0
17	Constant Speed	5	2	1	0.5
18	Blank	8			0
19	Constant Speed		4	4	1.5
20	Idle	6	2		0.3
21	Deceleration	6	2		0.3
22	Constant Speed		4	4	1.5
23	Idle-Acceleration		4	4	1.5
24	Constant Speed		4	4	1.5

TABLE 17. VEHICLE ODOR EVALUATION SUMMARY--STOCK MUFFLER INSTALLED

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3,087

Date: June 6, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

		Average Panel Responses				
Run No.*	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	I. Constant Speed	6.3	2.0	2.0	0.8	1.1
7	" "	6.1	2.0	1.8	0.9	0.8
16	" "	6.1	2.1	1.8	1.4	1.0
24	" "	6.6	2.3	2.0	1.1	1.8
		6.3	2.1	1.9	1.1	1.2
1	II. Constant Speed	5.9	2.0	1.9	0.9	0.8
12	" "	7.8	2.6	2.0	1.3	1.9
20	" "	7.4	2.4	2.0	1.4	1.4
22	" "	7.5	2.4	2.0	1.3	1.4
		7.2	2.4	2.0	1.2	1.4
14	III. Idle	6.1	2.0	1.8	1.9	0.8
15	"	6.1	2.0	1.6	1.9	0.6
17	"	5.0	1.3	1.1	1.0	0.4
21	"	5.4	2.0	1.4	1.3	0.8
		5.7	1.8	1.5	1.5	0.7
3	IV. Idle-Acceleration	6.6	2.0	2.0	0.9	1.5
6	" "	6.8	2.0	1.9	0.9	1.4
10	" "	6.8	1.9	1.8	1.0	1.3
23	" "	7.0	2.1	2.0	1.4	1.4
		6.8	2.0	1.9	1.1	1.4
2	V. Deceleration	4.5	1.3	1.0	0.9	0.1
8	"	5.5	1.8	1.8	1.0	0.8
11	"	5.3	1.8	1.1	1.0	0.8
18	"	4.5	1.0	1.0	0.8	0.4
		5.0	1.5	1.2	0.9	0.5

---

*Runs 5, 9, 13, and 19 were conducted without exhaust sample.

TABLE 17A. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("D" Diesel Composite Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 6, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run	Operating	"D" Diesel Composite Responses						
No.	Condition	0	4	5	6	7	8	Average
1	Constant Speed			1	7			5.9
2	Deceleration		4	4				4.5
3	Idle-Acceleration				3	5		6.6
4	Constant Speed				6	2		6.3
5	Blank	8						0
6	Idle-Acceleration				2	6		6.8
7	Constant Speed				7	1		6.1
8	Deceleration			4	4			5.5
9	Blank	8						0
10	Idle-Acceleration				2	6		6.8
11	Deceleration		1	4	3			5.3
12	Constant Speed					2	6	7.8
13	Blank	8						0
14	Idle				7	1		6.1
15	Idle				7	1		6.1
16	Constant Speed				7	1		6.1
17	Idle		1	6	1			5.0
18	Deceleration		4	4				4.5
19	Blank	8						0
20	Constant Speed				1	3	4	7.4
21	Idle			5	3			5.4
22	Constant Speed				1	2	5	7.5
23	Idle-Acceleration					8		7.0
24	Constant Speed				3	5		6.6

TABLE 17B. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 6, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run	Operating	"B" Burnt-Smoky Responses				
No.	Condition	0	1	2	3	Average
1	Constant Speed			8		2.0
2	Deceleration		6	2		1.3
3	Idle-Acceleration			8		2.0
4	Constant Speed			8		2.0
5	Blank	8				0
6	Idle-Acceleration			8		2.0
7	Constant Speed			8		2.0
8	Deceleration		2	6		1.8
9	Blank	8				0
10	Idle-Acceleration		1	7		1.9
11	Deceleration		2	6		1.8
12	Constant Speed			3	5	2.6
13	Blank	8				0
14	Idle			8		2.0
15	Idle			8		2.0
16	Constant Speed			7	1	2.1
17	Idle		6	2		1.3
18	Deceleration		8			1.0
19	Blank	8				0
20	Constant Speed			5	3	2.4
21	Idle			8		2.0
22	Constant Speed			5	3	2.4
23	Idle-Acceleration			7	1	2.1
24	Constant Speed			6	2	2.3

TABLE 17C. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("O" Oily Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 6, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		1	7	1.9
2	Deceleration		8		1.0
3	Idle-Acceleration			8	2.0
4	Constant Speed			8	2.0
5	Blank	8			0
6	Idle-Acceleration		1	7	1.9
7	Constant Speed		2	6	1.8
8	Deceleration		2	6	1.8
9	Blank	8			0
10	Idle-Acceleration		2	6	1.8
11	Deceleration		7	1	1.1
12	Constant Speed			8	2.0
13	Blank	8			0
14	Idle		2	6	1.8
15	Idle		3	5	1.6
16	Constant Speed		2	6	1.8
17	Idle		7	1	1.1
18	Deceleration		8		1.0
19	Blank	8			0
20	Constant Speed			8	2.0
21	Idle		5	3	1.4
22	Constant Speed			8	2.0
23	Idle-Acceleration			8	2.0
24	Constant Speed			8	2.0

TABLE 17D. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 6, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	1	7		0.9
2	Deceleration	1	7		0.9
3	Idle-Acceleration	1	7		0.9
4	Constant Speed	2	6		0.8
5	Blank	8			0
6	Idle-Acceleration	1	7		0.9
7	Constant Speed	1	7		0.9
8	Deceleration	1	6	1	1.0
9	Blank	8			0
10	Idle-Acceleration		8		1.0
11	Deceleration		8		1.0
12	Constant Speed		6	2	1.3
13	Blank	8			0
14	Idle		1	7	1.9
15	Idle		1	7	1.9
16	Constant Speed		5	3	1.4
17	Idle		8		1.0
18	Deceleration	2	6		0.8
19	Blank	8			0
20	Constant Speed		5	3	1.4
21	Idle		6	2	1.3
22	Constant Speed		6	2	1.3
23	Idle-Acceleration		5	3	1.4
24	Constant Speed		7	1	1.1

TABLE 17E. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("P" Pungent Standard)

Vehicle: Bus 678	Date: June 6, 1968
Test Days: 35	Operating Condition: See Table 2
Test Mileage: 3087	Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Constant Speed	2	6		0.8
2	Deceleration	7	1		0.1
3	Idle-Acceleration	1	2	5	1.5
4	Constant Speed		7	1	1.1
5	Blank	8			
6	Idle-Acceleration		5	3	1.4
7	Constant Speed	2	6		0.8
8	Deceleration	2	6		0.8
9	Blank	8			0
10	Idle-Acceleration		6	2	1.3
11	Deceleration	2	6		0.8
12	Constant Speed		1	7	1.9
13	Blank	8			0
14	Idle	3	4	1	0.8
15	Idle	3	5		0.6
16	Constant Speed	1	6	1	1.0
17	Idle	5	3		0.4
18	Deceleration	5	3		0.4
19	Blank	8			0
20	Constant Speed		5	3	1.4
21	Idle	2	6		0.8
22	Constant Speed		5	3	1.4
23	Idle-Acceleration	1	6	1	1.0
24	Constant Speed	1	5	2	1.8

TABLE 18. COMPUTATION OF "U" STATISTIC FOR ODOR PANEL RESPONSES CATALYTIC MUFFLER CODE "Z"-1 VS STOCK MUFFLER

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 5 & 6, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality					Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I	1	S*	Z†	Z	S	Z	IV	1	S	S	Z	Z**	Z
20 mph	2	S	Z	Z**	S	Z	Idle-	2	Z**	Z**	Z**	S**	Z
40 hp	3	S**	Z	S**	Z	S	Acceleration	3	S**	Z**	S**	Z	S
	4	Z**	Z**	S**	Z	S		4	S**	S**	Z	S**	S
	5	Z	S**	Z	S	S		5	S**	S**	Z	Z**	S
	6	S	S**	Z	Z	Z		6	Z**	Z**	S	Z	Z**
	7	Z	S	S	Z	Z		7	Z	Z**	S	S	S**
	8	Z	S	S	S	S		8	Z	S	S	S	Z
	U_s‡	1.5	1	4	5	3		U_s	2.5	8	2.5	5	7.5
II	1	Z	Z	Z	S	Z	V	1	S	S	S**	S	S
40 mph	2	S	Z	Z	Z	Z**	Deceleration	2	S	Z	S**	S	Z
40 hp	3	Z	Z**	S	Z	S**		3	Z	Z	Z**	Z**	Z
	4	Z	S**	S**	S	S		4	Z	Z**	Z**	Z**	Z**
	5	S	Z	S**	S	S		5	Z	S**	Z**	S**	S**
	6	S	S	S**	S**	Z		6	S**	Z	S**	S**	S
	7	Z**	S	Z**	Z**	Z		7	Z**	S	S**	Z	S
	8	S**	S	Z	Z	S		8	S	S	S	Z	Z
	U_s	5.5	1.5	7.5	6.5	6.5		U_s	7.5	5.5	1	2	7.5
III	1	Z	Z	Z	S**	Z							
Idle	2	S	Z	S**	Z**	Z							
	3	Z	S	Z**	Z	Z**							
	4	S	S**	Z	Z**	S**							
	5	Z	S**	Z	S**	S							
	6	S	Z**	S	Z	S**							
	7	S	Z**	S	S	S**							
	8	Z	S**	S	S	Z**							
	U_s	7	5	2.5	5	3.5							

---

*"S" stands for stock muffler reading.
†"Z" stands for Code "Z"-1 catalytic muffler.
‡U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 19. COMPARISON OF SMOKE READINGS FOR STOCK MUFFLER AND CATALYTIC MUFFLER "Z"-1 INSTALLED

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 4 & 6, 1968
Operating Conditions: See Table 7
Fuel: EM-3A-F (No. 1 Diesel)

Constant Speed Results (all open rack-- maximum output)

Type Operation	Vehicle Speed, mph	Load Hp	PHS Smoke Readings, Percent Opacity		
			Max	Min	Average
A. Stock	20	46	17.0	17.0	17.0
"Z"-1	20	45	18.0	17.0	17.7
Net Change					+0.7
B. Stock	25	58	13.0	11.0	12.0
"Z"-1	25	59	13.0	11.0	12.0
Net Change					0
C. Stock	30	68	11.0	11.0	11.0
"Z"-1	30	68	11.0	10.0	10.7
Net Change					-0.3
D. Stock	35	78	10.0	9.0	9.3
"Z"-1	35	76	10.0	8.0	9.0
Net Change					-0.3

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Average
Start of engine			
Stock	11.0	8.0	9.7
"Z"-1	11.0	10.0	10.3
Net Change			+0.6
During acceleration			
Stock	13.0	6.0	8.3
"Z"-1	9.0	7.0	1.1
Net Change			-0.6
After upshift			
Stock	8.0	8.0	8.0
"Z"-1	8.0	8.0	8.0
Net Change			0

TABLE 20. SUMMARY OF EXHAUST EMISSIONS MEASUREMENT CATALYTIC MUFFLER CODE "Z"-1 VS STOCK MUFFLER

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 4 & 7, 1968
Operating Conditions: See Table 10
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Run No.	CO, ppm		CO_2, percent		Acrolein, ppm		Aliphatic* Aldehydes, ppm		Formaldehyde, ppm		NO_x, ppm		SO_2, ppm		Adjusting Factor	
		Stock	"Z"-1	Stock	"Z"-1	Stock	"Z"-1	Stock	"Z"-1	Stock	"Z"-1	Stock	"Z"-1	Stock	"Z"-1	Stock	"Z"-1
I	1	800	850	4.40	4.70	3.47	4.69	33.08	33.63	16.03	17.31	843.15	762.30	0.499	0.429		
20 mph	5	900	700	4.05	4.20	3.53	4.82	33.99	32.75	14.70	18.60	831.60	785.40	0.706	0.568		
40 hp	9	660	740	4.00	4.15	2.17	4.82	36.26	29.21	20.09	18.64	658.35	785.40	0.789	0.803		
	13	660	-	4.00	-	1.94	-	31.07	-	12.50	-	843.15	-	0.568	-		
As-measured average		755	763	4.11	4.35	2.78	4.77	33.60	31.86	15.83	18.18	794.06	777.70	0.641	0.600		
Adjusted average†		2720	2590	14.8	14.75	10.0	16.2	120.9	108.1	57.0	61.8	2850	2640	2.31	2.04	3.60	3.40
II	3	195	185	3.30	3.15	1.75	1.73	24.57	21.24	6.46	9.99	600.60	554.40	0.623	0.582		
40 mph	7	175	185	3.25	3.25	1.64	1.98	25.25	20.36	11.03	9.32	565.95	565.95	0.831	0.720		
40 hp	11	180	185	3.05	3.05	1.28	2.84	25.25	23.90	11.03	11.32	635.25	589.05	0.983	0.956		
	15	175	-	3.10	-	1.56	-	26.46	-	10.43	-	600.60	-	1.660	-		
As-measured average		181	185	3.18	3.15	1.56	2.18	25.38	21.83	9.74	10.21	600.60	569.80	1.020	0.753		
Adjusted average		849	875	14.90	14.87	7.30	10.30	118.5	103.0	455	48.30	2810	2680	4.78	2.56	4.69	4.73
III	4	200	260	0.80	0.80	3.13	2.84	27.41	22.13	10.77	11.99	219.45	173.25	0.208	0.083		
Idle	8	200	240	0.80	0.80	2.40	2.84	28.16	22.13	12.50	10.65	207.90	196.35	0.194	0.180		
	12	195	210	0.80	0.70	2.43	3.21	25.01	21.24	9.43	8.66	219.45	207.90	0.346	0.083		
	16	195	-	0.80	-	2.84	-	27.44	-	12.65	-	207.90	-	0.485	-		
As-measured average		198	237	0.80	0.77	2.70	2.96	27.01	21.83	11.34	10.43	213.68	192.50	0.308	0.115		
Adjusted average		3620	4490	14.65	14.50	49.50	56.0	495	414	209.5	197.0	3920	3640	5.65	2.175	18.3	18.9
IIIa	2	200	200	3.50	3.15	2.62	2.96	27.41	23.90	10.05	9.99	681.45	623.70	0.568	0.443		
30 mph	6	195	210	3.20	3.55	2.52	2.84	30.10	21.24	16.17	9.99	693.00	704.55	0.817	0.609		
40 hp	10	195	195	3.20	3.15	1.79	3.09	27.19	25.67	11.76	12.65	623.70	658.35	0.831	0.845		
	14	195	-	3.25	-	2.33	-	28.42	-	12.65	-	623.70	-	1.250	-		
As-measured average		196	202	3.29	3.26	2.32	2.96	28.28	23.60	12.66	10.88	655.46	662.20	0.866	0.632		
Adjusted average		890	924	14.90	14.90	10.52	13.50	128.0	107.8	57.40	49.60	2970	3020	2.93	2.88	4.54	4.57

---

*Total as ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO plus CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 21. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 4 & 7, 1968
Operating Conditions: See Table 10
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	CO	CO_2	Acrolein	Aldehydes	Formaldehyde	NO_x	SO_2
I	1	S*	S	S	Z	S	S	Z
20 mph	2	S	S	S	S	S	Z	S
40 hp	3	Z†	S	S	Z	S	Z	S**
	4	Z	Z	S	S	Z	Z	Z**
	5	S	Z	Z	Z	Z	S	S
	6	Z	S	Z	S	Z	S	S
	7	S	Z	Z	S	S	S	Z
	U_s‡	5	2	0	9	3	9	6.5
II	1	S	S**	S	Z	S	Z	Z
40 mph	2	S	Z**	S	Z	Z	Z**	S
40 hp	3	S	S	S	Z	Z	S**	Z
	4	Z	Z**	Z	S	S	Z	S
	5	Z	S**	S	S	S	S	Z
	6	Z	Z	Z	S	S	S	S
	7	S	S	Z	S	Z	S	S
	U_s	3	6	1	12	6	10.5	9
III	1	S	Z	S	Z	Z	Z	Z
Idle	2	S	S**	S	Z	S	Z	Z
0 hp	3	S	S**	S	Z	Z	S**	Z
	4	S	S**	S**	S	S	S**	S
	5	Z	S**	Z**	S	Z	Z**	S
	6	Z	Z**	Z**	S	S	S	S
	7	Z	Z**	Z	S	S	S	S
	U_s	0	8	1	12	9	11	12
IIIa	1	S**	Z	S	Z	Z	Z**	Z
30 mph	2	S**	Z	S	Z	Z	S**	S
40 hp	3	Z**	S	S	Z	S	S**	Z
	4	S**	S	S	S	S	Z	S
	5	Z**	S	Z	S	Z**	S	S
	6	S**	S	Z	S	S**	S	Z
	7	Z	Z	Z	S	S	Z	S
	U_s	3	8	0	12	9.5	5	8

---

*"S" stands for stock muffler reading.

†"Z" stands for Code "Z"-1 catalytic muffler.

‡U_s must equal 0, 1, or 2 to show statistical difference with eight relative rankings. U_s must equal 0 or 1 to show significant difference with seven relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 22. SUMMARY OF PRESSURE AND TEMPERATURE MEASUREMENTS CATALYTIC MUFFLER CODE "Z"-1 VS STOCK MUFFLER

Vehicle: Bus 678
Test Days: 35
Test Mileage: 3087

Date: June 5 & 6, 1968
Operating Conditions: See Tables 11, 12 & 13
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Muffler Installed		Muffler Pressures, in. Hg			Muffler Temperatures, °F			Air Box Pressure, in. Hg.
			Inlet	Outlet	Differential	Inlet	Outlet	Differential	
I 20 mph 40 hp	Stock	Max	0.80	0.4	0.6	441	395	51	1.2
		Min	0.70	0.2	0.3	408	380	22	0.9
		Avg	0.75	0.3	0.5	427	386	41	1.1
	Catalytic	Max	0.9	0.3	0.6	437	365	73	1.2
		Min	0.7	0.1	0.6	420	347	68	0.8
		Avg	0.8	0.2	0.6	426	356	71	1.0
II 40 mph 40 hp	Stock	Max	3.0	1.00	2.0	484	450	64	6.2
		Min	2.8	0.90	1.8	446	400	19	5.8
		Avg	2.9	0.95	1.9	466	426	40	6.0
	Catalytic	Max	3.1	1.3	1.90	480	373	132	6.2
		Min	3.1	1.3	1.80	464	348	91	5.9
		Avg	3.1	1.3	1.85	471	362	109	6.0
III Idle	Stock	Max	0.2	0.1	0.1	357	337	(40)	0.8
		Min	0.2	0.1	0.1	291	329	(20)	0.8
		Avg	0.2	0.1	0.1	313	334	(31)	0.8
	Catalytic	Max	0.2	0.1	0.1	269	368	(99)*	0.90
		Min	0.2	0.1	0.1	252	323	(68)	0.80
		Avg	0.2	0.1	0.1	262	342	(80)	0.85
IIIa 30 mph 40 hp	Stock	Max	1.9	0.6	1.3	406	390	44	3.0
		Min	1.6	0.6	1.0	395	362	12	3.0
		Avg	1.7	0.6	1.1	402	375	27	3.0
	Catalytic	Max	1.9	0.6	1.3	454	371	88	3.0
		Min	1.8	0.5	1.0	434	340	37	2.9
		Avg	1.85	0.6	1.2	440	361	79	3.0

Air Box Pressures, Engine under No Load

Engine, rpm	Stock Muffler, in. Hg	Catalytic Muffler, in. Hg	Reference - Min Pressure at Max Exhaust Pressure†
1200	3.05	2.98	2.9
1800	7.05	6.60	7.0
2100	9.15	8.10	9.4

---

*Parentheses ( ) denote the inlet muffler temperature less than the outlet muffler temperature.
†From GMC Truck and Coach Division Diesel Engine Manual X-6310, page 173.

TABLE 23. SCHEDULE OF CATALYTIC MUFFLER CODE "Z"-2 EVALUATION AND ENGINE MAINTENANCE SUMMARY

Date	Test Time, days	Total Mileage	Test Miles	Description of Test Conducted Maintenance Performed
5/6/68	0	250,108	0	Installed Code "Z"-2 muffler on Bus 680
6/7/68	32	252,545	2,437	Removed Code "Z"-2 muffler from Bus 680
6/10/68				Evaluated odor from Bus 678-stock muffler
6/11/68				Installed Code "Z"-2 muffler on Bus 678 and evaluated odor and smoke
6/12/68				Evaluated emissions - Code "Z"-2

End of Test

Note: No engine maintenance performed during test period.

TABLE 24. VEHICLE ODOR EVALUATION SUMMARY-- CATALYTIC MUFFLER CODE "Z"-2 MUFFLER INSTALLED

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
8	I. Constant Speed	6.8	2.1	1.8	1.4	1.3
11	" "	6.6	2.0	1.9	1.4	1.0
20	" "	7.3	2.3	2.0	1.3	1.3
24	" "	6.6	2.1	2.0	1.3	1.1
		6.8	2.1	1.9	1.4	1.2
1	II. Constant Speed	6.0	2.0	1.8	1.0	1.0
5	" "	6.0	2.0	1.9	1.1	0.9
17	" "	7.1	2.1	1.9	1.8	1.1
21	" "	7.1	2.1	2.1	1.1	1.3
		6.6	2.1	1.9	1.3	1.1
3	III. Idle	4.4	1.3	1.1	0.9	0.3
6	"	4.9	1.4	1.0	1.3	0.3
14	"	5.4	1.4	1.3	0.9	0.8
16	"	5.3	1.6	1.1	1.0	0.6
		5.0	1.4	1.1	1.0	0.5
2	IV. Idle-Acceleration	6.4	2.0	1.6	1.4	1.0
9	" "	6.3	2.0	1.9	0.9	1.0
19	" "	6.8	2.0	2.0	1.1	1.1
22	" "	6.5	2.3	2.0	1.3	1.1
		6.5	2.1	1.9	1.2	1.1
4	V. Deceleration	4.9	1.4	1.1	0.6	0.4
10	"	5.0	1.6	1.1	1.0	0.6
13	"	5.1	1.4	1.3	0.9	0.9
23	"	5.8	1.9	1.6	1.3	0.8
		5.2	1.6	1.3	1.0	0.7

---

*Runs 7, 12, 15, and 18 were conducted without exhaust sample.

TABLE 24A. VEHICLE ODOR EVALUATION RESULTS-- "Z"-2 MUFFLER

("D" Diesel Composite Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	4	5	6	7	8	Average
1	Constant Speed				8			6.0
2	Idle-Acceleration			3	5			6.4
3	Idle		5	3				4.4
4	Deceleration		2	5	1			4.9
5	Constant Speed				8			6.0
6	Idle		2	5	1			4.9
7	Blank	8						0
8	Constant Speed				2	6		6.8
9	Idle-Acceleration			1	4	3		6.3
10	Deceleration			8				5.0
11	Constant Speed				3	5		6.6
12	Blank	8						0
13	Deceleration			7	1			5.1
14	Idle			5	3			5.4
15	Blank	8						0
16	Idle			6	2			5.3
17	Constant Speed				1	5	2	7.1
18	Blank	8						0
19	Idle-Acceleration				2	6		6.8
20	Constant Speed				1	4	3	7.3
21	Constant Speed					7	1	7.1
22	Idle-Acceleration				5	2	1	6.5
23	Deceleration			3	4	1		5.8
24	Constant Speed				3	5		6.6

TABLE 24B. VEHICLE ODOR EVALUATION RESULTS-- "Z"-2 MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed			8		2.0
2	Idle-Acceleration			8		2.0
3	Idle		6	2		1.3
4	Deceleration		5	3		1.4
5	Constant Speed			8		2.0
6	Idle		5	3		1.4
7	Blank	8				0
8	Constant Speed			7	1	2.1
9	Idle-Acceleration		1	6	1	2.0
10	Deceleration		3	5		1.6
11	Constant Speed			8		2.0
12	Blank	8				0
13	Deceleration		5	3		1.4
14	Idle		5	3		1.4
15	Blank	8				0
16	Idle		3	5		1.6
17	Constant Speed			7	1	2.1
18	Blank	8				0
19	Idle-Acceleration			8		2.0
20	Constant Speed			6	2	2.3
21	Constant Speed			7	1	2.1
22	Idle-Acceleration			6	2	2.3
23	Deceleration		1	7		1.9
24	Constant Speed			7	1	2.1

TABLE 24C. VEHICLE ODOR EVALUATION RESULTS-- "Z"-2 MUFFLER

("O" Oily Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Constant Speed		2	6		1.8
2	Idle-Acceleration		3	5		1.6
3	Idle		7	1		1.1
4	Deceleration		7	1		1.1
5	Constant Speed		1	7		1.9
6	Idle		8			1.0
7	Blank	8				0
8	Constant Speed		2	6		1.8
9	Idle-Acceleration		1	7		1.9
10	Deceleration		7	1		1.1
11	Constant Speed		1	7		1.9
12	Blank	8				0
13	Deceleration		6	2		1.3
14	Idle		6	2		1.3
15	Blank	8				0
16	Idle		7	1		1.1
17	Constant Speed		1	7		1.9
18	Blank	8				0
19	Idle-Acceleration			8		2.0
20	Constant Speed			8		2.0
21	Constant Speed			7	1	2.1
22	Idle-Acceleration		2	4	2	2.0
23	Deceleration		3	5		1.6
24	Constant Speed			8		2.0

TABLE 24D. VEHICLE ODOR EVALUATION RESULTS-- "Z"-2 MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	1	6	1	1.0
2	Idle-Acceleration	2	1	5	1.4
3	Idle	2	5	1	0.9
4	Deceleration	3	5		0.6
5	Constant Speed		7	1	1.1
6	Idle		6	2	1.3
7	Blank	8			0
8	Constant Speed		5	3	1.4
9	Idle-Acceleration	1	7		0.9
10	Deceleration	1	6	1	1.0
11	Constant Speed		5	3	1.4
12	Blank	8			0
13	Deceleration	1	7		0.9
14	Idle	1	7		0.9
15	Blank	8			0
16	Idle	1	6	1	1.0
17	Constant Speed		2	6	1.8
18	Blank	8			0
19	Idle-Acceleration		7	1	1.1
20	Constant Speed	1	4	3	1.3
21	Constant Speed	1	5	2	1.1
22	Idle-Acceleration		6	2	1.3
23	Deceleration		6	2	1.3
24	Constant Speed		6	2	1.3

TABLE 24E. VEHICLE ODOR EVALUATION RESULTS-- "Z"-2 MUFFLER

("P" Pungent Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed		8		1.0
2	Idle-Acceleration	1	6	1	1.0
3	Idle	6	2		0.3
4	Deceleration	5	3		0.4
5	Constant Speed	1	7		0.9
6	Idle	6	2		0.3
7	Blank	8			0
8	Constant Speed		6	2	1.3
9	Idle-Acceleration	1	6	1	1.0
10	Deceleration	3	5		0.6
11	Constant Speed		8		1.0
12	Blank	8			0
13	Deceleration	1	7		0.9
14	Idle	2	6		0.8
15	Blank	8			0
16	Idle	3	5		0.6
17	Constant Speed		7	1	1.1
18	Blank	8			0
19	Idle-Acceleration		7	1	1.1
20	Constant Speed		6	2	1.3
21	Constant Speed		6	2	1.3
22	Idle-Acceleration		7	1	1.1
23	Deceleration	3	4	1	0.8
24	Constant Speed	1	5	2	1.1

TABLE 25. VEHICLE ODOR EVALUATION SUMMARY-- STOCK MUFFLER INSTALLED

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 10, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run	Operating	Average Panel Responses				
		"D"	"B"	"O"	"A"	"P"
No.*	Condition	Composite	Burnt	Oily	Aromatic	Pungent
1	I. Constant Speed	5.9	1.7	1.3	0.7	1.0
3	" "	6.3	2.1	1.3	1.1	1.0
11	" "	5.3	2.0	1.6	0.8	1.0
24	" "	6.3	2.0	1.6	1.1	1.0
		5.5	2.0	1.5	0.9	1.0
5	II. Constant Speed	6.8	2.0	1.5	1.1	1.1
9	" "	6.7	1.7	1.7	1.4	1.0
16	" "	7.0	2.0	1.7	0.9	1.5
21	" "	7.0	2.1	2.0	1.4	1.1
		6.9	1.9	1.7	1.2	1.2
6	III. Idle	6.7	2.0	2.0	1.3	1.1
10	"	6.3	2.0	1.5	0.7	1.5
17	"	5.6	1.6	1.3	1.1	0.6
22	"	5.3	1.6	1.1	1.1	0.3
		6.0	1.8	1.5	1.1	0.9
13	IV. Idle-Acceleration	7.5	2.3	2.1	1.2	1.8
15	" "	7.5	2.5	2.0	1.2	1.6
18	" "	7.3	1.7	2.0	1.6	1.4
20	" "	6.7	1.7	2.0	1.2	1.4
		7.3	2.1	2.0	1.3	1.6
2	V. Deceleration	5.5	1.6	1.2	0.8	0.5
7	"	5.0	1.5	1.0	0.8	0.3
14	"	5.6	1.6	1.3	0.8	0.5
23	"	4.8	1.5	1.1	0.8	0.5
		5.2	1.6	1.2	0.8	0.5

---

*Runs 4, 8, 12, and 19 were conducted without exhaust sample.

TABLE 25A. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("D" Diesel Composite Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 10, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses 0	4	5	6	7	8	Average
1	Constant Speed			1	7			5.9
2	Deceleration			4	4			5.5
3	Constant Speed				5	3		6.3
4	Blank	8						0
5	Constant Speed				2	6		6.8
6	Idle				1	7		6.7
7	Deceleration			8				5.0
8	Blank	8						0
9	Constant Speed				1	7		6.7
10	Idle			1	3	4		6.3
11	Constant Speed				7	1		5.3
12	Blank	8						0
13	Idle-Acceleration					4	4	7.5
14	Deceleration			3	4	1		5.6
15	Idle-Acceleration					4	4	7.5
16	Constant Speed					8		7.0
17	Idle			3	5			5.6
18	Idle-Acceleration					5	3	7.3
19	Blank	8						0
20	Idle-Acceleration				4	1	3	6.7
21	Constant Speed				2	4	2	7.0
22	Idle			6	2			5.3
23	Deceleration		3	3	2			4.8
24	Constant Speed			1	3	4		6.3

TABLE 25B. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 10, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Average
1	Constant Speed		1	7		1.7
2	Deceleration		2	6		1.6
3	Constant Speed			7	1	2.1
4	Blank	8				0
5	Constant Speed			8		2.0
6	Idle			8		2.0
7	Deceleration		4	4		1.5
8	Blank	8				0
9	Constant Speed			6	2	1.7
10	Idle		1	6	1	2.0
11	Constant Speed			8		2.0
12	Blank	8				0
13	Idle-Acceleration			5	3	2.3
14	Deceleration		2	6		1.6
15	Idle-Acceleration			4	4	2.5
16	Constant Speed			8		2.0
17	Idle		2	6		1.6
18	Idle-Acceleration			6	2	1.7
19	Blank	8				0
20	Idle-Acceleration			6	2	1.7
21	Constant Speed			7	1	2.1
22	Idle		2	6		1.6
23	Deceleration		3	5		1.5
24	Constant Speed			8		2.0

TABLE 25C. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("O" Oily Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 10, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	3	Average
1	Constant Speed		5	3		1.3
2	Deceleration		6	2		1.2
3	Constant Speed		5	3		1.3
4	Blank	8				0
5	Constant Speed		3	5		1.5
6	Idle			8		2.0
7	Deceleration		8			1.0
8	Blank	8				0
9	Constant Speed		1	7		1.7
10	Idle		3	5		1.5
11	Constant Speed		2	6		1.6
12	Blank	8				0
13	Idle-Acceleration			7	1	2.1
14	Deceleration		5	3		1.3
15	Idle-Acceleration			8		2.0
16	Constant Speed		1	7		1.7
17	Idle		5	3		1.3
18	Idle-Acceleration			8		2.0
19	Blank	8				0
20	Idle-Acceleration		1	6	1	2.0
21	Constant Speed		1	6	1	2.0
22	Idle		7	1		1.1
23	Deceleration		7	1		1.1
24	Constant Speed		2	6		1.6

TABLE 25D. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 10, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Average
1	Constant Speed	2	6		0.7
2	Deceleration	1	7		0.8
3	Constant Speed		7	1	1.1
4	Blank	8			0
5	Constant Speed		7	1	1.1
6	Idle	2	2	4	1.3
7	Deceleration	1	7		0.8
8	Blank	8			0
9	Constant Speed	1	3	4	1.4
10	Idle	3	4	1	0.7
11	Constant Speed	1	7		0.8
12	Blank	8			0
13	Idle-Acceleration	1	4	3	1.2
14	Deceleration	1	7		0.8
15	Idle-Acceleration		6	2	1.2
16	Constant Speed	3	3	2	0.9
17	Idle	1	5	2	1.1
18	Idle-Acceleration		3	5	1.6
19	Blank	8			0
20	Idle-Acceleration		6	2	1.2
21	Constant Speed		5	3	1.4
22	Idle	1	5	2	1.1
23	Deceleration	1	7		0.8
24	Constant Speed	2	3	3	1.1

TABLE 25E. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("P" Pungent Standard)

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 10, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Constant Speed		8		1.0
2	Deceleration	4	4		0.5
3	Constant Speed		8		1.0
4	Blank	8			0
5	Constant Speed		7	1	1.1
6	Idle	1	5	2	1.1
7	Deceleration	6	2		0.3
8	Blank	8			0
9	Constant Speed	1	6	1	1.0
10	Idle		4	4	1.5
11	Constant Speed	2	4	2	1.0
12	Blank	8			0
13	Idle-Acceleration		2	6	1.8
14	Deceleration	4	4		0.5
15	Idle-Acceleration		3	5	1.6
16	Constant Speed		4	4	1.5
17	Idle	3	5		0.6
18	Idle-Acceleration		5	3	1.4
19	Blank	8			0
20	Idle-Acceleration		5	3	1.4
21	Constant Speed		7	1	1.1
22	Idle	6	2		0.3
23	Deceleration	6	2		0.3
24	Constant Speed	2	4	2	1.0

TABLE 26. COMPUTATION OF "U" STATISTIC FOR ODOR PANEL RESPONSES CATALYTIC MUFFLER CODE "Z"-2 VS STOCK MUFFLER

Vehicle: Bus 678
Test Days: 32
Test Mileage 2437

Date: June 10 & 11, 1968
Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"	Operating Conditions	Relative Ranking	Odor Quality "D"	"B"	"O"	"A"	"P"
I	1	S*	S	S	S	S**	IV	1	Z	S	Z	Z	Z
20 mph	2	S	S**	S	S	S**	Idle-	2	Z	S	Z	Z	Z
40 hp	3	S	Z**	S	S	S**	Acceleration	3	Z	Z	S**	S	Z
	4	S	S**	S	S	S**		4	S	Z	Z**	S	Z
	5	Z†	Z**	Z	Z	Z**		5	Z	Z	S**	S	S
	6	Z	S**	Z	Z	Z		6	S	S**	Z**	Z	S
	7	Z	Z**	Z	Z	Z		7	S	Z**	S**	Z	S
	8	Z	Z	Z	Z	Z		8	S	S	S	S	S
	U_s‡	0	3	0	0	2		U_s	1	7.5	3	6	0
II	1	Z	S	S	S	Z	V	1	S	Z	S	Z	S
40 mph	2	Z	S**	S	Z	S**	Deceleration	2	Z	Z	Z**	S	Z
40 hp	3	S	S**	S	Z**	Z**		3	S**	S	S**	S	S
	4	S	Z**	Z	S**	S**		4	Z**	S	Z**	S	S
	5	S	Z**	Z	Z**	Z**		5	Z	S**	S	S	S
	6	S	S**	Z	S	S**		6	S	Z**	S**	Z	Z
	7	Z	Z**	S	S	Z		7	S	S**	Z**	Z	Z
	8	Z	Z**	Z	Z	S		8	Z	Z	Z	Z	Z
	U_s	8	5	3	8	5.5		U_s	7.5	7	5.5	4	3
III	1	Z	Z	Z	S	Z**							
Idle	2	Z	Z	Z**	Z	S**							
	3	S**	Z	S**	Z	Z**							
	4	Z**	S**	Z**	Z	S**							
	5	Z	Z**	S**	S	Z**							
	6	S	S**	Z**	S	Z							
	7	S	S	S	Z**	S							
	8	S	S	S	S**	S							
	U_s	1.5	1	2.5	6.5	4.5							

---

*"S" stands for stock muffler reading.

†"Z" stands for Code "Z"-2 catalytic muffler.

‡U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 27. COMPARISON OF SMOKE READINGS FOR STOCK MUFFLER AND CATALYTIC MUFFLER "Z"-2 INSTALLED

Vehicle: Bus 678	Date: June 6 & 11, 1968
Test Days: 32	Operating Conditions: See Table 7
Test Mileage: 2437	Fuel: EM-3A-F (No. 1 Diesel)

Constant Speed Results (all open rack - maximum output)

Type Operation		Vehicle Speed, mph	Load, Hp	PHS Smoke Readings, Percent Opacity		
				Max	Min	Average
A.	Stock	20	46	17.0	17.0	17.0
	"Z"-2	20	46	20.0	16.0	18.0
	Net Change					+1.0
B.	Stock	25	58	13.0	11.0	12.0
	"Z"-2	25	56	12.0	11.0	11.7
	Net Change					-0.3
C.	Stock	30	68	11.0	11.0	11.0
	"Z"-2	30	69	10.0	10.0	10.0
	Net Change					-1.0
D.	Stock	35	78	10.0	9.0	9.3
	"Z"-2	35	79	10.0	9.0	9.7
	Net Change					+0.4

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Average
Start of engine			
Stock	11.0	8.0	9.7
"Z"-2	10.0	8.0	9.3
Net Change			-0.4
During acceleration			
Stock	13.0	6.0	8.3
"Z"-2	11.0	8.0	9.3
Net Change			+1.0
After upshift			
Stock	8.0	8.0	8.0
"Z"-2	9.0	8.0	8.7
Net Change			+0.7

TABLE 28. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS CATALYTIC MUFFLER CODE "Z"-2 VS STOCK MUFFLERS

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 7 & 12, 1968
Operating Conditions: See Table 10
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Run No.	CO, ppm		CO_2, percent		Acrolein, ppm		Aliphatic* Aldehyde, ppm		Formaldehyde, ppm		NO_x, ppm		SO_2, ppm		Adjusting Factor	
		Stock	"Z"-2	Stock	"Z"-2	Stock	"Z"-2	Stock	"Z"-2	Stock	"Z"-2	Stock	"Z"-2	Stock	"Z"-2	Stock	"Z"-2
I	1	800	900	4.40	5.00	3.47	4.92	33.08	40.04	16.03	20.80	843.15	808.50	0.499	0.374		
20 mph	5	900	740	4.05	4.50	3.53	2.47	33.99	34.63	14.70	7.98	831.60	762.30	0.706	0.153		
40 hp	9	660	950	4.00	4.80	2.17	4.94	36.26	39.81	20.09	20.58	658.35	796.95	0.789	0.131		
	13	660	1000	4.00	4.70	1.94	4.57	31.07	40.12	12.50	20.55	843.15	739.20	0.568	0.165		
As-measured average		755	898	4.11	4.75	2.78	4.23	33.60	38.80	15.83	17.48	794.06	776.74	0.641	0.206		
Adjusted average†		2700	2780	14.79	14.70	9.96	13.30	120.4	120.0	56.8	54.15	2840	2400	2.26	0.645	3.59	3.10
II	3	195	190	3.30	4.55	1.75	1.70	24.57	28.86	6.46	11.60	600.60	600.60	0.623	0.959		
40 mph	7	175	185	3.25	3.30	1.64	0.97	25.25	26.94	11.03	8.70	565.95	589.05	0.831	0.128		
40 hp	11	180	180	3.05	3.50	1.28	2.84	25.25	28.16	11.03	10.29	635.25	565.95	0.983	0.118		
	15	175	190	3.10	3.30	1.56	1.85	26.46	29.41	10.43	16.21	600.60	600.60	1.660	0.125		
As-measured average		181	186	3.18	3.66	1.56	1.84	25.38	28.34	9.74	16.05	600.60	589.05	1.020	0.333		
Adjusted average		850	760	14.90	14.90	7.32	7.50	119.0	115.5	45.6	65.5	2820	2440	3.055	1.360	4.70	4.08
III	4	200	200	0.80	0.90	3.13	2.81	27.41	23.09	10.77	10.15	219.45	254.10	0.208	0.570		
Idle	8	200	200	0.80	0.90	2.40	2.59	28.16	25.25	12.50	12.50	207.90	242.55	0.194	0.586		
	12	195	210	0.80	0.90	2.43	2.96	25.01	24.28	9.43	13.23	219.45	219.45	0.346	0.725		
	16	195	200	0.80	0.90	2.84	2.72	27.44	25.35	12.65	10.81	207.90	242.55	0.485	0.806		
As-measured average		198	203	0.80	0.90	2.70	2.77	27.01	24.49	11.34	11.67	213.68	239.66	0.308	0.872		
Adjusted average		3625	3305	14.6	14.65	49.4	45.1	494.0	399	207.5	190	3900	3805	5.64	1.420	18.30	16.30
IIIa	2	200	230	3.50	3.85	2.62	2.97	27.41	41.37	10.05	22.48	681.45	646.80	0.566	0.584		
30 mph	6	195	210	3.20	3.70	2.52	2.64	30.10	31.75	16.17	12.33	693.00	646.80	0.817	0.111		
40 hp	10	195	195	3.20	3.75	1.79	3.83	27.19	30.10	11.76	14.70	623.70	635.25	0.831	0.146		
	14	195	210	3.25	3.80	2.33	3.09	28.42	30.42	12.65	14.67	623.70	623.70	1.250	0.180		
As-measured average		196	211	3.29	3.78	2.32	3.13	28.28	33.41	12.66	18.02	655.46	638.14	0.866	0.255		
Adjusted average		890	835	14.90	14.95	10.50	12.35	128.0	132.0	57.40	71.0	2970	2515	2.60	1.005	4.54	3.95

---

*Total as ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO plus CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 29. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS

Vehicle: Bus 678
Test Days: 32
Test Mileage: 2437

Date: June 7 & 12, 1968
Operating Conditions: See Table 10
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	CO	CO_2	Acrolein	Aldehyde	Formaldehyde	NO_x	SO_2
I 20 mph 40 hp	1	S*	S	S	S	Z	S	Z
	2	S	S	S	S	S	Z	Z
	3	Z†	S	Z	S	S	Z	Z
	4	S	S	S	Z	S	Z	Z
	5	S**	Z	S	S	S	Z	S
	6	Z**	Z	Z	Z	Z	S	S
	7	Z	Z	Z	Z	Z	S	S
	8	Z	Z	Z	Z	Z	S	S
	U_s‡	2.5	0††	2	1	4	4	0
II 40 mph 40 hp	1	S	S	Z	S	S	S**	Z
	2	S	S	S	S	Z	Z**	Z
	3	S**	S	S	S	Z	Z	Z
	4	Z**	S**	S	S	S	S**	S
	5	Z	Z**	Z	Z	S	S**	S
	6	Z	Z**	S	Z	S	Z**	S
	7	Z	Z	Z	Z	Z	Z**	S
	8	S	Z	Z	Z	Z	S	Z
	U_s	4.5	1††	5	0	6	6	4
III Idle 0 hp	1	S	Z	S	Z	S	S	S
	2	S	Z	S	Z	Z	S	S
	3	S**	Z	Z	S	S	S**	S
	4	S**	Z	Z	Z	Z	S**	S
	5	Z**	S	Z	Z	S**	Z**	Z
	6	Z**	S	S	S	Z**	Z	Z
	7	Z**	S	Z	S	S	Z	Z
	8	Z	S	S	S	Z	Z	Z
	U_s	3	0††	7	2	7	1	0
IIIa 30 mph 40 hp	1	S**	S	S	S	S	S**	Z
	2	S**	S	S	S	S	Z**	S
	3	Z**	S	S	S	Z	S**	Z
	4	S**	S	S	Z**	S	Z	Z
	5	S	Z	Z	S**	Z	Z	S
	6	Z	Z	Z	Z	Z	Z	Z
	7	Z	Z	Z	Z	S	S	S
	8	Z	Z	Z	Z	Z	S	S
	U_s	2.5	0††	0	0.5	4	7	4

---

*"S" stands for stock muffler reading.

†"Z" stands for Code "Z" - 2 catalytic muffler.

‡U_s must equal 0, 1, or 2 to show statistical difference with eight relative rankings.
U_s must equal 0 or 1 to show significant difference with seven relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

††Measured data within accuracy and reliability of measurement method employed. No statistical difference exists.

TABLE 30. SUMMARY OF PRESSURE AND TEMPERATURE MEASUREMENTS CATALYTIC MUFFLER CODE "Z"-2 VS STOCK MUFFLER

Vehicle: Bus 678	Date: June 10 & 11, 1968
Test Days: 32	Operating Conditions: See Tables 11, 12 & 13
Test Mileage: 2437	Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Muffler Installed		Muffler Pressures, in. Hg			Muffler Temperatures, °F			Air Box Pressure, in. Hg
			Inlet	Outlet	Differential	Inlet	Outlet	Differential	
I	Stock	Max	0.8	0.2	0.6	435	423	42	1.1
20 mph		Min	0.8	0.2	0.6	391	349	12	0.9
40 hp		Avg	0.8	0.2	0.6	416	391	26	1.0
	Catalytic	Max	1.2	0.4	0.9	485	449	36	1.5
		Min	1.1	0.4	0.8	439	427	12	1.5
		Avg	1.1	0.4	0.9	468	442	26	1.5
II	Stock	Max	2.9	2.0	2.0	468	443	58	5.8
40 mph		Min	2.7	0.8	0.9	440	396	25	5.7
40 hp		Avg	2.8	1.3	1.7	455	413	42	5.7
	Catalytic	Max	3.9	1.1	2.9	544	506	64	6.7
		Min	3.9	1.1	2.8	496	466	22	6.3
		Avg	3.9	1.1	2.9	523	484	39	6.5
III	Stock	Max	0.2	0.1	0.1	293	328	(34)*	0.8
Idle		Min	0.2	0.1	0.1	286	316	(27)	0.8
		Avg	0.2	0.1	0.1	291	322	(30)	0.8
	Catalytic	Max	0.2	0.1	0.1	341	360	(50)	0.8
		Min	0.2	0.1	0.1	305	355	(19)	0.8
		Avg	0.2	0.1	0.1	323	358	(35)	0.8
IIIa	Stock	Max	1.7	0.6	1.1	452	373	89	3.0
30 mph		Min	1.6	0.6	1.0	377	354	23	2.9
40 hp		Avg	1.6	0.6	1.0	410	361	48	3.0
	Catalytic	Max	2.3	1.7	1.7	447	426	23	3.7
		Min	2.3	1.6	1.6	341	360	18	3.5
		Avg	2.3	1.7	1.7	408	403	21	3.6

Air Box Pressures, Engine under No Load

Engine, rpm	Stock Muffler, in. Hg	Catalytic Muffler, in. Hg	Reference - Min Pressure at Max Exhaust Pressure†
1200	3.05	3.10	2.9
1800	7.05	7.05	7.0
2100	9.15	8.45	9.4

---

*Parentheses ( ) denote inlet muffler temperature less than outlet muffler temperature.

†From GMC Truck and Coach Division Diesel Engine Manual X-6310, page 173.

TABLE 31. VEHICLE ODOR EVALUATION SUMMARY-- "W" MUFFLER INSTALLED

Vehicle: Bus 678
Date: June 17, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

		Average Panel Responses				
Run No.*	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	I. Constant Speed	6.9	2.3	1.9	1.1	1.1
7	" "	6.0	2.0	1.9	1.0	1.1
13	" "	7.5	2.6	1.8	1.3	1.3
18	" "	6.8	2.1	1.6	1.3	1.3
		6.8	2.3	1.8	1.2	1.2
2	II. Constant Speed	3.1	1.0	0.9	0.6	0
11	" "	5.9	1.9	1.9	0.9	0.9
16	" "	4.3	1.1	1.0	0.9	0
22	" "	5.6	1.6	1.3	0.9	0.4
		4.7	1.4	1.3	0.8	0.3
6	III. Idle	3.9	1.1	1.0	0.8	0.6
8	"	3.1	1.0	0.8	0.9	0
19	"	2.9	1.0	0.8	0.8	0
24	"	3.1	1.0	0.9	0.8	0
		3.3	1.0	0.9	0.8	0.2
4	IV. Idle-Acceleration	7.0	2.0	2.0	0.9	1.9
12	" "	7.4	2.3	2.0	1.1	2.0
17	" "	7.0	2.1	2.0	1.0	1.8
23	" "	7.0	2.0	2.0	1.1	1.3
		7.1	2.1	2.0	1.0	1.8
1	V. Deceleration	3.8	1.0	0.9	0.9	0.1
9	"	4.5	1.3	1.1	0.6	0.3
14	"	3.9	1.0	1.0	0.8	0
21	"	4.3	1.1	0.9	0.6	0.3
		4.1	1.1	1.0	0.7	0.2

---

*Runs 5, 10, 15, and 20 were conducted without exhaust sample.

TABLE 31A. VEHICLE ODOR EVALUATION RESULTS-- "W" MUFFLER

("D" Diesel Composite Standard)

Vehicle: Bus 678
Date: June 17, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses								
		0	2	3	4	5	6	7	8	Average
1	Deceleration			3	4	1				3.8
2	Constant Speed			7	1					3.1
3	Constant Speed						4	1	3	6.9
4	Idle-Acceleration							8		7.0
5	Blank	8								0
6	Idle			2	5	1				3.9
7	Constant Speed					1	6	1		6.0
8	Idle			7	1					3.1
9	Deceleration			1	2	5				4.5
10	Blank	8								0
11	Constant Speed					1	7			5.9
12	Idle-Acceleration							5	3	7.4
13	Constant Speed						1	2	5	7.5
14	Deceleration			1	7					3.9
15	Blank	8								0
16	Constant Speed			1	4	3				4.3
17	Idle-Acceleration							8		7.0
18	Constant Speed						5		3	6.8
19	Idle		1	7						2.9
20	Blank	8								0
21	Deceleration			1	4	3				4.3
22	Constant Speed					3	5			5.6
23	Idle-Acceleration							8		7.0
24	Idle			7	1					3.1

TABLE 31B. VEHICLE ODOR EVALUATION RESULTS-- "W" MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: June 17, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Deceleration		8			1.0
2	Constant Speed		8			1.0
3	Constant Speed			6	2	2.3
4	Idle-Acceleration			8		2.0
5	Blank	8				0
6	Idle		7	1		1.1
7	Constant Speed			8		2.0
8	Idle		8			1.0
9	Deceleration		6	2		1.3
10	Blank	8				0
11	Constant Speed		1	7		1.9
12	Idle-Acceleration			6	2	2.3
13	Constant Speed			3	5	2.6
14	Deceleration		8			1.0
15	Blank	8				0
16	Constant Speed		7	1		1.1
17	Idle-Acceleration			7	1	2.1
18	Constant Speed		1	5	2	2.1
19	Idle		8			1.0
20	Blank	8				0
21	Deceleration		7	1		1.1
22	Constant Speed		3	5		1.6
23	Idle-Acceleration			8		2.0
24	Idle		8			1.0

TABLE 31C. VEHICLE ODOR EVALUATION RESULTS--"W" MUFFLER

("O" Oily Standard)

Vehicle: Bus 678
Date: June 17, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Deceleration	1	7		0.9
2	Constant Speed	1	7		0.9
3	Constant Speed		1	7	1.9
4	Idle-Acceleration			8	2.0
5	Blank	8			0
6	Idle	1	6	1	1.0
7	Constant Speed		1	7	1.9
8	Idle	2	6		0.8
9	Deceleration		7	1	1.1
10	Blank	8			0
11	Constant Speed		1	7	1.9
12	Idle-Acceleration			8	2.0
13	Constant Speed		2	6	1.8
14	Deceleration		8		1.0
15	Blank	8			0
16	Constant Speed		8		1.0
17	Idle-Acceleration			8	2.0
18	Constant Speed		3	5	1.6
19	Idle	2	6		0.8
20	Blank	8			0
21	Deceleration	1	7		0.9
22	Constant Speed		6	2	1.3
23	Idle-Acceleration			8	2.0
24	Idle	1	7		0.9

TABLE 31D. VEHICLE ODOR EVALUATION RESULTS-- "W" MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 678
Date: June 17, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Deceleration	1	7		0.9
2	Constant Speed	3	5		0.6
3	Constant Speed	3	1	4	1.1
4	Idle-Acceleration	2	5	1	0.9
5	Blank	8			0
6	Idle	3	4	1	0.8
7	Constant Speed	2	4	2	1.0
8	Idle	1	7		0.9
9	Deceleration	3	5		0.6
10	Blank	8			0
11	Constant Speed	1	7		0.9
12	Idle-Acceleration	1	5	2	1.1
13	Constant Speed		6	2	1.3
14	Deceleration	2	6		0.8
15	Blank	8			0
16	Constant Speed	1	7		0.9
17	Idle-Acceleration	1	6	1	1.0
18	Constant Speed	2	2	4	1.3
19	Idle	2	6		0.8
20	Blank	8			0
21	Deceleration	3	5		0.6
22	Constant Speed	2	5	1	0.9
23	Idle-Acceleration	1	5	2	1.1
24	Idle	2	6		0.8

TABLE 31E. VEHICLE ODOR EVALUATION RESULTS-- "W" MUFFLER

("P" Pungent Standard)

Vehicle: Bus 678
Date: June 17, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Deceleration	7	1		0.1
2	Constant Speed	8			0
3	Constant Speed		7	1	1.1
4	Idle-Acceleration		1	7	1.9
5	Blank	8			0
6	Idle	3	5		0.6
7	Constant Speed		7	1	1.1
8	Idle	8			0
9	Deceleration	6	2		0.3
10	Blank	8			0
11	Constant Speed	1	7		0.9
12	Idle-Acceleration			8	2.0
13	Constant Speed		6	2	1.3
14	Deceleration	8			0
15	Blank	8			0
16	Constant Speed	8			0
17	Idle-Acceleration		2	6	1.8
18	Constant Speed		6	2	1.3
19	Idle	8			0
20	Blank	8			0
21	Deceleration	6	2		0.3
22	Constant Speed	5	3		0.4
23	Idle-Acceleration		6	2	1.3
24	Idle	8			0

TABLE 32. VEHICLE ODOR EVALUATION SUMMARY-- STOCK MUFFLER INSTALLED

Vehicle: Bus 678
Date: June 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	I. Constant Speed	5.0	1.8	1.3	0.9	0.8
12	" "	6.9	2.0	2.0	1.1	1.5
17	" "	7.3	2.1	2.0	1.3	1.0
24	" "	7.0	2.0	2.0	1.3	1.5
		6.6	2.0	1.8	1.2	1.2
3	II. Constant Speed	7.8	2.5	2.0	1.3	1.3
8	" "	5.9	1.8	1.8	1.1	0.8
19	" "	7.8	2.5	2.0	1.1	1.9
22	" "	6.9	2.0	2.0	1.1	1.5
		7.1	2.2	2.0	1.2	1.4
5	III. Idle	5.8	1.9	1.8	1.0	0.8
10	"	6.0	2.0	1.9	1.0	1.0
13	"	5.5	1.9	1.3	0.9	0.9
20	"	5.0	1.8	1.5	0.9	0.8
		5.6	1.9	1.6	1.0	0.9
4	IV. Idle-Acceleration	7.9	2.3	2.0	1.0	2.0
6	" "	8.0	2.5	2.0	1.3	2.0
16	" "	7.9	2.5	2.0	1.1	1.9
23	" "	8.0	2.5	2.0	1.1	2.0
		8.0	2.5	2.0	1.1	2.0
2	V. Deceleration	5.3	1.9	1.8	0.9	1.0
9	"	5.1	1.8	1.5	1.0	0.8
14	"	5.1	1.5	1.3	1.3	0.8
21	"	5.8	2.0	1.5	1.1	0.9
		5.3	1.8	1.5	1.1	0.9

---

*Runs 7, 11, 15, and 18 were conducted without exhaust sample.

TABLE 32A. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("D" Diesel Composite Standard)

Vehicle: Bus 678
Date: June 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	4	5	6	7	8	Average
1	Constant Speed			8				5.0
2	Deceleration			6	2			5.3
3	Constant Speed					2	6	7.8
4	Idle-Acceleration					1	7	7.9
5	Idle			2	6			5.8
6	Idle-Acceleration						8	8.0
7	Blank	8						0
8	Constant Speed			1	7			5.9
9	Deceleration			7	1			5.1
10	Idle				8			6.0
11	Blank	8						0
12	Constant Speed				1	7		6.9
13	Idle			4	4			5.5
14	Deceleration		1	5	2			5.1
15	Blank	8						0
16	Idle-Acceleration					1	7	7.9
17	Constant Speed					6	2	7.3
18	Blank	8						0
19	Constant Speed					2	6	7.8
20	Idle			8				5.0
21	Deceleration			2	6			5.8
22	Constant Speed				1	7		6.9
23	Idle-Acceleration						8	8.0
24	Constant Speed					8		7.0

TABLE 32B. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 678
Date: June 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		2	6		1.8
2	Deceleration		1	7		1.9
3	Constant Speed			4	4	2.5
4	Idle-Acceleration			6	2	2.3
5	Idle		1	7		1.9
6	Idle-Acceleration			4	4	2.5
7	Blank	8				0
8	Constant Speed		2	6		1.8
9	Deceleration		2	6		1.8
10	Idle			8		2.0
11	Blank	8				0
12	Constant Speed			8		2.0
13	Idle		1	7		1.9
14	Deceleration		4	4		1.5
15	Blank	8				0
16	Idle-Acceleration			4	4	2.5
17	Constant Speed			7	1	2.1
18	Blank	8				0
19	Constant Speed			4	4	2.5
20	Idle		2	6		1.8
21	Deceleration			8		2.0
22	Constant Speed			8		2.0
23	Idle-Acceleration			4	4	2.5
24	Constant Speed			8		2.0

TABLE 32C. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("O" Oily Standard)

Vehicle: Bus 678
Date: June 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		6	2	1.3
2	Deceleration		2	6	1.8
3	Constant Speed			8	2.0
5	Idle-Acceleration			8	2.0
5	Idle		2	6	1.8
6	Idle-Acceleration			8	2.0
7	Blank	8			0
8	Constant Speed		2	6	1.8
9	Deceleration		4	4	1.5
10	Idle		1	7	1.9
11	Blank	8			0
12	Constant Speed			8	2.0
13	Idle		6	2	1.3
14	Deceleration		6	2	1.3
15	Blank	8			0
16	Idle-Acceleration			8	2.0
17	Constant Speed			8	2.0
18	Blank	8			0
19	Constant Speed			8	2.0
20	Idle		4	4	1.5
21	Deceleration		4	4	1.5
22	Constant Speed			8	2.0
23	Idle-Acceleration			8	2.0
24	Constant Speed			8	2.0

TABLE 32D. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 678
Date: June 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	1	7		0.9
2	Deceleration	1	7		0.9
3	Constant Speed		6	2	1.3
4	Idle-Acceleration	2	4	2	1.0
5	Idle		8		1.0
6	Idle-Acceleration		6	2	1.3
7	Blank	8			0
8	Constant Speed		7	1	1.1
9	Deceleration		8		1.0
10	Idle	2	4	2	1.0
11	Blank	8			0
12	Constant Speed		7	1	1.1
13	Idle	1	7		0.9
14	Deceleration		6	2	1.3
15	Blank	8			0
16	Idle-Acceleration	1	5	2	1.1
17	Constant Speed		6	2	1.3
18	Blank	8			0
19	Constant Speed	1	5	2	1.1
20	Idle	1	7		0.9
21	Deceleration		7	1	1.1
22	Constant Speed	1	5	2	1.1
23	Idle-Acceleration		7	1	1.1
24	Constant Speed		6	2	1.3

TABLE 32E. VEHICLE ODOR EVALUATION RESULTS-- STOCK MUFFLER

("P" Pungent Standard)

Vehicle: Bus 678
Date: June 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Constant Speed	2	6		0.8
2	Deceleration		8		1.0
3	Constant Speed		6	2	1.3
4	Idle-Acceleration			8	2.0
5	Idle	2	6		0.8
6	Idle-Acceleration			8	2.0
7	Blank	8			0
8	Constant Speed	2	6		0.8
9	Deceleration	2	6		0.8
10	Idle	1	6	1	1.0
11	Blank	8			0
12	Constant Speed		4	4	1.5
13	Idle	1	7		0.9
14	Deceleration	2	6		0.8
15	Blank	8			0
16	Idle-Acceleration		1	7	1.9
17	Constant Speed	1	6	1	1.0
18	Blank	8			0
19	Constant Speed		1	7	1.9
20	Idle	2	6		0.8
21	Deceleration	1	7		0.9
22	Constant Speed		4	4	1.5
23	Idle-Acceleration			8	2.0
24	Constant Speed		4	4	1.5

TABLE 33. COMPUTATION OF "U" STATISTIC FOR ODOR PANEL RESPONSES CATALYTIC MUFFLER CODE "W" VS STOCK MUFFLER

Vehicle: Bus 678
Date: June 17 & 18, 1968

Operating Conditions: See Table 2
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"
I 20 mph 40 hp	1	S*	S	S	S	S
	2	W†	S**	W	W	S
	3	W	W**	W	S**	W
	4	S**	S**	W	W**	W
	5	W**	W**	W	W**	W
	6	S	S**	S	W**	W
	7	S	W	S	S**	S
	8	W	W	S	S**	S
	U_s‡	7.5	2.5	4	7.5	8
II 40 mph 40 hp	1	W	W	W	W	W
	2	W	W	W	W	W
	3	W	W	W	W	W
	4	W**	S	S	W	S
	5	S**	W	W	S	W
	6	S	S	S	S	S
	7	S	S	S	S	S
	8	S	S	S	S	S
	U_s	0.5	1	1	0	1
III Idle	1	W	W	W	W	W
	2	W	W	W	W	W
	3	W	W	W	W	W
	4	W	W	W	W**	W
	5	S	S	S	S**	S
	6	S	S	S	S**	S
	7	S	S	S	S	S
	8	S	S	S	S	S
	U_s	0	0	0	1	0
IV Idle- Acceleration	1	W	W	W**	W	W
	2	W	W	W**	W**	W
	3	W	W	W**	S**	W**
	4	W	W**	W**	W**	S**
	5	S	S**	S**	S**	W**
	6	S	S	S**	W**	S**
	7	S	S	S**	S**	S**
	8	S	S	S**	S	S**
	U_s	0	0.5	8	4.5	3
V Deceleration	1	W	W	W	W	W
	2	W	W	W	W	W
	3	W	W	W	W	W
	4	W	W	W	W**	W
	5	S	S	S	S**	S
	6	S	S	S	S	S
	7	S	S	S	S	S
	8	S	S	S	S	S
	U_s	0	0	0	0.5	0

---

*"S" stands for stock muffler reading.

†"W" stands for Code W catalytic muffler.

‡U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 34. COMPARISON OF SMOKE READINGS FOR STOCK MUFFLER AND CATALYTIC MUFFLER "W" INSTALLED

Vehicle: Bus 678
Date: June 14 & 18, 1968
Operating Conditions: See Table 7
Fuel: EM-3A-F (No. 1 Diesel)

Constant Speed Results (all open rack - maximum output)

Type Operation	Vehicle Speed, mph	Load, hp	PHS Smoke Readings, Percent Opacity Max	Min	Average
A. Stock	20	45	18.0	14.0	16.0
"W"	20	46	14.0	13.0	13.3
Net Change					-2.7
B. Stock	25	58	14.0	12.0	13.3
"W"	25	58	11.0	10.0	10.3
Net Change					-3.0
C. Stock	30	69	14.0	12.0	13.3
"W"	30	69	10.0	8.0	9.0
Net Change					-4.3
D. Stock	35	79	12.0	10.0	11.0
"W"	35	77	9.0	6.0	7.7
Net Change					-3.3

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity Max	Min	Average
Start of engine			
Stock	5.0	4.0	4.3
"W"	9.0	6.0	7.0
Net Change			+2.7
During acceleration			
Stock	9.0	6.0	7.7
"W"	8.0	5.0	6.3
Net Change			-1.4
After upshift			
Stock	12.0	8.0	9.7
"W"	11.0	8.0	9.7
Net Change			0

TABLE 35. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS CATALYTIC MUFFLER CODE "W" VS STOCK MUFFLER

Vehicle: Bus 678
Date: June 14 & 19, 1968
Operating Conditions: See Table 10
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Run No.	Co, ppm		Co$_2$, percent		Acrolein, ppm		Aliphatic* Aldehyde, ppm		Formaldehyde, ppm		NO$_x$, ppm		SO$_2$, ppm		Adjusting Factor	
		Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"	Stock	"W"
I 20 mph 40 hp	1 5 9 13	520 450 660 600	175 80 80 70	3.25 3.40 3.55 3.50	4.40 4.20 4.40 4.80	3.66 3.31 4.04 3.92	1.85 0.74 0.88 0.26	23.30 24.50 28.42 25.48	35.59 22.33 19.60 17.64	11.76 11.90 12.65 11.90	11.60 8.09 9.67 5.95	693.00 681.45 669.90 635.25	646.80 658.35 646.80 704.55	0.263 0.817 1.094 1.108	0.111 0.111 0.172 0.167		
As-measured average		558	81	3.43	4.35	3.73	0.93	25.43	23.74	12.05	8.83	669.90	664.13	0.821	0.140		
Adjusted average†		2421	287	14.89	15.40	16.19	3.29	110.37	84.04	52.30	31.26	2907.4	2351	3.56	0.496	4.34	3.54
II 40 mph 40 hp	3 7 11 15	180 210 195 180	40 60 40 60	2.70 2.80 3.15 2.50	3.45 3.30 3.40 3.30	2.21 2.45 2.70 2.45	0.25 0.12 0.13 0.13	20.39 23.30 27.44 22.54	20.39 18.45 18.62 16.66	9.56 9.56 12.65 11.16	5.88 4.41 4.46 3.72	542.85 554.40 531.31 554.40	450.45 519.75 508.20 508.20	0.457 0.859 1.177 1.094	0.111 0.126 0.125 0.266		
As-measured average		191	50	2.79	3.36	2.45	0.16	23.42	18.53	10.74	4.62	545.74	496.65	0.897	0.157		
Adjusted average		1022	205	14.93	13.74	13.11	0.65	125.30	75.79	57.46	18.90	2919.7	2031.3	4.80	0.642	5.35	4.09
III Idle	4 8 12 16	200 200 200 195	10 40 30 40	0.70 0.90 0.90 0.80	0.90 0.90 0.90 1.00	3.31 2.94 3.06 2.82	0.12 0.12 0.13 0.13	25.25 23.52 23.52 24.50	11.65 13.59 13.72 15.68	11.76 9.67 9.67 10.42	5.15 2.94 3.72 3.72	207.90 242.55 231.00 231.00	196.35 196.35 207.90 231.00	0.166 0.360 0.499 0.568	0.111 0.141 0.125 0.182		
As-measured average		199	30	0.83	0.93	3.03	0.13	24.20	13.66	10.38	3.88	228.11	207.90	0.398	0.140		
Adjusted average		3512	485	14.65	15.02	53.48	2.10	427.13	220.61	183.21	62.66	4026.1	3357.6	7.02	2.26	17.65	16.15
IIIa 30 mph 40 hp	2 6 10 14	210 200 260 190	40 50 10 60	2.90 3.00 3.00 2.50	3.50 3.45 3.60 3.50	2.57 2.94 2.94 2.94	0.74 0.37 0.38 0.26	22.33 24.28 23.52 24.50	22.33 17.48 16.66 16.66	10.29 8.82 10.42 11.90	8.82 6.62 7.44 3.72	589.05 589.05 565.95 565.95	519.75 554.40 552.85 531.30	0.402 0.859 1.094 0.997	0.111 0.111 0.111 0.111		
As-measured average		215	40	2.85	3.51	2.77	0.44	23.66	18.28	10.11	8.83	577.50	539.58	0.838	0.111		
Adjusted average		1127	171	14.93	14.99	14.51	1.88	123.98	78.06	52.98	37.70	3026.1	2304	4.39	0.474	5.24	4.27

---

*Total as ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO plus CO$_2$) in the exhaust using "as-measured" average CO and CO$_2$ measurements.

TABLE 36. COMPUTATION OF "U" STATISTIC FOR EXHAUST EMISSIONS

Vehicle: Bus 678
Date: June 14 & 19, 1968

Operating Conditions: See Table 10
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Relative Ranking	CO	CO_2	Acrolein	Aldehyde	Formaldehyde	NO_x	SO_2
I	1	W	S	W	W	W	S	W
20 mph	2	W	S	W	W	W	W	W
40 hp	3	W	S	W	W	W	W	W
	4	W	S	W	S	W	W	W
	5	S*	W†	S	S	S	S	S
	6	S	W	S	S	S	S	[illegible]
	7	S	W	S	S	S	S	S
	8	S	W	S	W	S	W	S
	U_s‡	0	0	0	4	0	7	0
II	1	W	S	W	W	W	W	W
40 mph	2	W	S	W	W	W	W	W
40 hp	3	W	S	W	W	W	W	W
	4	W	S	W	W**	W	W	W
	5	S	W	S	S**	S	S	S
	6	S	W	S	S	S	S	S
	7	S	W	S	S	S	S	S
	8	S	W	S	S	S	S	S
	U_s	0	0	0	0.5	0	0	0
III	1	W	S	W	W	W	W	W
Idle	2	W	S	W	W	W	W	W
0 hp	3	W	S	W	W	W	W**	W
	4	W	S**	W	W	W	S**	S
	5	S	W**	S	S	S	W**	W
	6	S	W	S	S	S	S**	S
	7	S	W	S	S	S	S	S
	8	S	W	S	S	S	S	S
	U_s	0	0.5	0	0	0	2	1
IIIa	1	W	S	W	W	W	W	W
30 mph	2	W	S	W	W	W	W	W
40 hp	3	W	S	W	W	W	W	W
	4	W	S	W	S**	S**	W	W
	5	S	W	S	W**	W**	S	S
	6	S	W	S	S	S	S	S
	7	S	W	S	S	S	S	S
	8	S	W	S	S	S	S	S
	U_s	0	0	0	0.5	0.5	0	0

---

*"S" stands for stock muffler reading.

†"W" stands for Code "W" catalytic muffler.

‡U_s must equal 0, 1, or 2 to show statistical difference with eight relative rankings.
U_s must equal 0 or 1 to show significant difference with seven relative rankings.

**Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute (T).

TABLE 37. SUMMARY OF PRESSURE AND TEMPERATURE MEASUREMENTS CATALYTIC MUFFLER CODE "W" VS STOCK MUFFLER

Vehicle: Bus 678
Date: June 14 & 18, 1968
Operating Conditions: See Tables 11, 12 & 13
Fuel: EM-3A-F (No. 1 Diesel)

Operating Conditions	Muffler Installed		Muffler Pressures, in. Hg			Muffler Temperatures, °F			Air Box Pressure, in. Hg.
			Inlet	Outlet	Differential	Inlet	Outlet	Differential	
I 20 mph 40 hp	Stock	Max	0.10	0.40	0.40	524	355	178	1.00
		Min	0	0.25	0.15	493	322	138	1.00
		Avg	0.05	0.29	0.24	504	342	161	1.00
	Catalytic	Max	0.40	0.10	0.40	549	457	187	1.00
		Min	0.20	0	0.10	528	360	92	0.90
		Avg	0.26	0.08	0.18	541	395	154	0.96
II 40 mph 40 hp	Stock	Max	0.60	0.80	0.60	526	422	104	5.00
		Min	0.20	0.70	0.20	503	396	94	4.80
		Avg	0.30	0.75	0.45	515	412	101	4.90
	Catalytic	Max	0.80	0.50	0.40	546	458	150	4.60
		Min	0.80	0.40	0.30	533	391	88	4.60
		Avg	0.80	0.43	0.36	539	427	111	4.60
III Idle	Stock	Max	0.05	0.10	0.05	283	311	(30)*	0.90
		Min	0.05	0.10	0.05	278	305	(23)	0.80
		Avg	0.05	0.10	0.05	281	307	(27)	0.85
	Catalytic	Max	0.10	0.05	0.05	310	413	(105)	0.70
		Min	0.10	0.05	0.05	295	349	(50)	0.60
		Avg	0.10	0.05	0.05	304	374	(70)	0.63
IIIa 30 mph 40 hp	Stock	Max	0.40	0.60	0.50	497	370	138	2.60
		Min	0.10	0.40	0.10	475	346	109	2.30
		Avg	0.23	0.50	0.27	485	361	125	2.47
	Catalytic	Max	0.60	0.20	0.40	524	432	179	2.40
		Min	0.30	0.10	0.20	484	310	92	2.20
		Avg	0.47	0.13	0.33	499	360	139	2.30

Air Box Pressures, Engine under No Load

Engine, rpm	Stock Muffler, in. Hg	Catalytic Muffler, in. Hg	Reference - Min Pressure at Max Exhaust Pressure†
1200	2.45	2.20	2.9
1800	5.30	5.40	7.0
2100	8.20	7.05	9.4

---

*Parentheses ( ) denote the inlet muffler temperature less than the outlet muffler temperature.
†From GMC Truck and Coach Division Diesel Engine Manual X-6310, page 173.

TABLE 38. VEHICLE ODOR EVALUATION SUMMARY CATALYTIC MUFFLER CODE "V" INSTALLED

Vehicle: Bus 683
Date: January 23, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	5.2	1.7	1.4	1.1	0.9
5	" "	6.1	1.9	1.1	1.0	1.6
12	" "	5.3	1.6	1.2	1.1	1.2
13	" "	5.5	1.8	1.2	1.0	1.2
		5.5	1.8	1.2	1.1	1.2
3	30 mph at 40 hp	5.6	1.7	1.2	0.8	1.4
6	" "	5.7	1.8	1.2	1.2	1.2
10	" "	4.9	1.6	1.1	0.8	1.0
14	" "	4.7	1.2	1.0	0.9	1.0
		5.2	1.6	1.1	0.9	1.2
2	40 mph at 40 hp	5.6	1.8	1.0	0.8	1.0
7	" "	4.9	1.4	1.2	1.0	1.0
9	" "	5.1	1.5	1.0	1.0	1.0
16	" "	5.5	1.7	1.4	1.1	1.1
		5.3	1.6	1.2	1.0	1.0
4	Idle	5.2	1.4	1.3	1.1	1.1
8	"	6.3	1.7	1.2	1.2	1.5
11	"	5.7	1.4	1.0	1.0	0.9
15	"	5.9	1.7	1.1	1.0	1.3
		5.8	1.6	1.2	1.1	1.2
18	Idle-Acceleration	7.3	2.3	2.0	1.4	1.8
20	" "	5.7	1.9	1.6	1.2	1.2
21	" "	5.5	1.7	1.4	1.1	1.0
23	" "	6.2	1.9	1.6	1.0	1.2
		6.2	2.0	1.7	1.2	1.3
17	Deceleration	6.5	2.3	2.0	1.3	1.2
19	"	5.7	2.1	1.9	1.1	1.2
22	"	6.8	2.2	1.9	1.0	1.3
		6.3	2.2	1.9	1.1	1.2

TABLE 38A. VEHICLE ODOR EVALUATION RESULTS-- CODE "V" MUFFLER

("D" Diesel Composite Results)

Vehicle: Bus 683
Date: January 23, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	'D" Diesel Composite Responses					
		4	5	6	7	8	Avg
1	20 mph at 40 hp	2	5	2	1		5.2
2	40 mph at 40 hp		5	4	1		5.6
3	30 mph at 40 hp		4	6			5.6
4	Idle	2	4	4			5.2
5	20 mph at 40 hp			9	1		6.1
6	30 mph at 40 hp		3	7			5.7
7	40 mph at 40 hp	1	9				4.9
8	Idle			7	3		6.3
9	40 mph at 40 hp		9	1			5.1
10	30 mph at 40 hp	2	7	1			4.9
11	Idle		4	5	1		5.7
12	20 mph at 40 hp	1	5	4			5.3
13	20 mph at 40 hp		5	5			5.5
14	30 mph at 40 hp	3	7				4.7
15	Idle	2	1	7			5.9
16	40 mph at 40 hp		5	5			5.5
17	Deceleration			6	3	1	6.5
18	Idle-Acceleration				7	3	7.3
19	Deceleration			2	3	3	5.7
20	Idle-Acceleration		4	5	1		5.7
21	Idle-Acceleration		5	5			5.5
22	Deceleration		1	2	5	2	6.8
23	Idle-Acceleration		2	4	4		6.2
24	Deceleration						

TABLE 38B. VEHICLE ODOR EVALUATION RESULTS-- CODE "V" MUFFLER

("B" Burnt-Smoky Standards)

Vehicle: Bus 683
Date: January 23, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	20 mph at 40 hp	3	7		1.7
2	40 mph at 40 hp	2	8		1.8
3	30 mph at 40 hp	3	7		1.7
4	Idle	6	4		1.4
5	20 mph at 40 hp	1	9		1.9
6	30 mph at 40 hp	2	8		1.8
7	40 mph at 40 hp	6	4		1.4
8	Idle	3	7		1.7
9	40 mph at 40 hp	5	5		1.5
10	30 mph at 40 hp	4	6		1.6
11	Idle	6	4		1.4
12	20 mph at 40 hp	4	6		1.6
13	20 mph at 40 hp	2	8		1.8
14	30 mph at 40 hp	8	2		1.2
15	Idle	3	7		1.7
16	40 mph at 40 hp	3	7		1.7
17	Deceleration		7	3	2.3
18	Idle-Acceleration		7	3	2.3
19	Deceleration		9	1	2.1
20	Idle-Acceleration	2	7	1	1.9
21	Idle-Acceleration	3	7		1.7
22	Deceleration		8	2	2.2
23	Idle-Acceleration	2	7	1	1.9
24	Deceleration				

TABLE 38C. VEHICLE ODOR EVALUATION RESULTS-- CODE "V" MUFFLER

("O" Oily Standard)

Vehicle: Bus 683
Date: January 23, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"O" Oily Responses			
		0	1	2	Avg
1	20 mph at 40 hp		6	4	1.4
2	40 mph at 40 hp		10		1.0
3	30 mph at 40 hp		8	2	1.2
4	Idle		7	3	1.3
5	20 mph at 40 hp		9	1	1.1
6	30 mph at 40 hp		8	2	1.2
7	40 mph at 40 hp		8	2	1.2
8	Idle		8	2	1.2
9	40 mph at 40 hp		10		1.0
10	30 mph at 40 hp		9	1	1.1
11	Idle		10		1.0
12	20 mph at 40 hp		8	2	1.2
13	20 mph at 40 hp		8	2	1.2
14	30 mph at 40 hp		10		1.0
15	Idle	1	7	2	1.1
16	40 mph at 40 hp		6	4	1.4
17	Deceleration			10	2.0
18	Idle-Acceleration			10	2.0
19	Deceleration		1	9	1.9
20	Idle-Acceleration		4	6	1.6
21	Idle-Acceleration		6	4	1.4
22	Deceleration		1	9	1.9
23	Idle-Acceleration		4	6	1.6
24	Deceleration				

TABLE 38D. VEHICLE ODOR EVALUATION RESULTS-- CODE "V" MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 683
Date: January 23, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Avg
1	20 mph at 40 hp	1	7	2	1.1
2	40 mph at 40 hp	2	8		0.8
3	30 mph at 40 hp	2	8		0.8
4	Idle	1	7	2	1.1
5	20 mph at 40 hp	1	8	1	1.0
6	30 mph at 40 hp	1	6	3	1.2
7	40 mph at 40 hp	1	8	1	1.0
8	Idle	1	6	3	1.2
9	40 mph at 40 hp		10		1.0
10	30 mph at 40 hp	2	8		0.8
11	Idle	1	8	1	1.0
12	20 mph at 40 hp	1	7	2	1.1
13	20 mph at 40 hp		10		1.0
14	30 mph at 40 hp	1	9		0.9
15	Idle	2	6	2	1.0
16	40 mph at 40 hp		9	1	1.1
17	Deceleration	1	5	4	1.3
18	Idle-Acceleration		6	4	1.4
19	Deceleration	1	7	2	1.1
20	Idle-Acceleration		8	2	1.2
21	Idle-Acceleration		9	1	1.1
22	Deceleration	1	8	1	1.0
23	Idle-Acceleration	1	8	1	1.0
24	Deceleration				

TABLE 38E. VEHICLE ODOR EVALUATION RESULTS-- CODE "V" MUFFLER

("P" Pungent Standard)

Vehicle: Bus 683
Date: January 23, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	20 mph at 40 hp	1	9		0.9
2	40 mph at 40 hp		10		1.0
3	30 mph at 40 hp		6	4	1.4
4	Idle		9	1	1.1
5	20 mph at 40 hp		4	6	1.6
6	30 mph at 40 hp		8	2	1.2
7	40 mph at 40 hp		10		1.0
8	Idle	1	3	6	1.5
9	40 mph at 40 hp		10		1.0
10	30 mph at 40 hp		10		1.0
11	Idle	1	9		0.9
12	20 mph at 40 hp		8	2	1.2
13	20 mph at 40 hp		8	2	1.2
14	30 mph at 40 hp	1	8	1	1.0
15	Idle		7	3	1.3
16	40 mph at 40 hp		9	1	1.1
17	Deceleration		8	2	1.2
18	Idle-Acceleration		2	8	1.8
19	Deceleration		8	2	1.2
20	Idle-Acceleration		8	2	1.2
21	Idle-Acceleration		10		1.0
22	Deceleration		7	3	1.3
23	Idle-Acceleration		8	2	1.2
24	Deceleration				

TABLE 39. VEHICLE ODOR EVALUATION SUMMARY
STOCK MUFFLER INSTALLED

Vehicle: Bus 683
Date: January 24, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	Average Panel Response "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	5.3	1.3	1.2	1.0	1.0
5	" "	6.6	1.9	1.7	1.1	1.3
12	" "	6.3	1.9	1.8	1.2	1.3
13	" "	6.2	1.9	1.8	1.1	1.2
		6.1	1.8	1.6	1.1	1.2
3	30 mph at 40 hp	5.7	1.8	1.2	1.0	1.0
6	" "	6.4	2.0	1.9	1.0	1.1
10	" "	5.8	1.8	1.6	1.0	1.0
14	" "	5.7	1.9	1.7	1.1	1.0
		5.9	1.9	1.6	1.0	1.0
2	40 mph at 40 hp	5.7	1.7	1.3	1.0	1.1
7	" "	6.1	1.9	1.7	1.1	1.1
9	" "	6.0	1.9	1.7	0.9	1.0
16	" "	6.4	2.0	1.7	1.0	1.1
		6.1	1.9	1.6	1.0	1.1
4	Idle	6.1	2.0	1.6	1.1	1.0
8	"	5.6	1.8	1.4	1.2	1.1
11	"	5.7	1.9	1.6	1.2	1.0
15	"	5.7	1.8	1.7	1.3	0.9
		5.8	1.9	1.6	1.2	1.0
18	Idle-Acceleration	6.3	1.9	1.7	0.9	1.2
20	" "	6.3	1.9	1.8	1.2	1.1
21	" "	6.0	1.8	1.7	1.0	1.0
23	" "	6.0	1.9	1.8	1.2	1.0
		6.2	1.9	1.8	1.1	1.1
17	Deceleration	5.2	1.6	1.3	1.1	0.8
19	"	5.6	1.8	1.7	1.1	1.1
22	"	5.3	1.6	1.3	1.0	0.7
24	"	5.7	1.8	1.7	1.0	1.0
		5.5	1.7	1.5	1.1	0.9

TABLE 39A. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("D" Diesel Composite Results)

Vehicle: Bus 683
Date: January 24, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses				
		4	5	6	7	Avg
1	20 mph at 40 hp		7	3		5.3
2	40 mph at 40 hp	2		7	1	5.7
3	30 mph at 40 hp		3	7		5.7
4	Idle			9	1	6.1
5	20 mph at 40 hp			4	6	6.6
6	30 mph at 40 hp			6	4	6.4
7	40 mph at 40 hp		1	7	2	6.1
8	Idle		4	6		5.6
9	40 mph at 40 hp			10		6.0
10	30 mph at 40 hp		2	8		5.8
11	Idle		5	3	2	5.7
12	20 mph at 40 hp		1	5	4	6.3
13	20 mph at 40 hp			8	2	6.2
14	30 mph at 40 hp		3	7		5.7
15	Idle		3	7		5.7
16	40 mph at 40 hp			6	4	6.4
17	Deceleration		8	2		5.2
18	Idle-Acceleration			7	3	6.3
19	Deceleration		6	2	2	5.6
20	Idle-Acceleration			7	3	6.3
21	Idle-Acceleration		2	6	2	6.0
22	Deceleration		7	3		5.3
23	Idle-Acceleration		1	8	1	6.0
24	Deceleration		3	7		5.7

TABLE 39B. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 683
Date: January 24, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	Avg
1	20 mph at 40 hp	7	3	1.3
2	40 mph at 40 hp	3	7	1.7
3	30 mph at 40 hp	2	8	1.8
4	Idle		10	2.0
5	20 mph at 40 hp	1	9	1.9
6	30 mph at 40 hp		10	2.0
7	40 mph at 40 hp	1	9	1.9
8	Idle	2	8	1.8
9	40 mph at 40 hp	1	9	1.9
10	30 mph at 40 hp	2	8	1.8
11	Idle	1	9	1.9
12	20 mph at 40 hp	1	9	1.9
13	20 mph at 40 hp	1	9	1.9
14	30 mph at 40 hp	1	9	1.9
15	Idle	2	8	1.8
16	40 mph at 40 hp		10	2.0
17	Deceleration	4	6	1.6
18	Idle-Acceleration	1	9	1.9
19	Deceleration	2	8	1.8
20	Idle-Acceleration	1	9	1.9
21	Idle-Acceleration	2	8	1.8
22	Deceleration	4	6	1.6
23	Idle-Acceleration	1	9	1.9
24	Deceleration	2	8	1.8

TABLE 39C. VEHICLE ODOR EVALUATION RESULTS --STOCK MUFFLER

("O" Oily Standard)

Vehicle: Bus 683
Date: January 24, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"O" Oily Responses		
		1	2	Avg
1	20 mph at 40 hp	8	2	1.2
2	40 mph at 40 hp	7	3	1.3
3	30 mph at 40 hp	8	2	1.2
4	Idle	4	6	1.6
5	20 mph at 40 hp	3	7	1.7
6	30 mph at 40 hp	1	9	1.9
7	40 mph at 40 hp	3	7	1.7
8	Idle	6	4	1.4
9	40 mph at 40 hp	3	7	1.7
10	30 mph at 40 hp	4	6	1.6
11	Idle	4	6	1.6
12	20 mph at 40 hp	2	8	1.8
13	20 mph at 40 hp	2	8	1.8
14	30 mph at 40 hp	3	7	1.7
15	Idle	3	7	1.7
16	40 mph at 40 hp	3	7	1.7
17	Deceleration	7	3	1.3
18	Idle-Acceleration	3	7	1.7
19	Deceleration	3	7	1.7
20	Idle-Acceleration	2	8	1.8
21	Idle-Acceleration	3	7	1.7
22	Deceleration	7	3	1.3
23	Idle-Acceleration	2	8	1.8
24	Deceleration	3	7	1.7

TABLE 39D. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 683
Date: January 24, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	20 mph at 40 hp		10		1.0
2	40 mph at 40 hp		10		1.0
3	30 mph at 40 hp		10		1.0
4	Idle	1	7	2	1.1
5	20 mph at 40 hp	1	7	2	1.1
6	30 mph at 40 hp		10		1.0
7	40 mph at 40 hp	1	7	2	1.1
8	Idle	1	6	3	1.2
9	40 mph at 40 hp	1	9		0.9
10	30 mph at 40 hp	1	8	1	1.0
11	Idle	1	6	3	1.2
12	20 mph at 40 hp		8	2	1.2
13	20 mph at 40 hp		9	1	1.1
14	30 mph at 40 hp		9	1	1.1
15	Idle		7	3	1.3
16	40 mph at 40 hp	1	8	1	1.0
17	Deceleration		9	1	1.1
18	Idle-Acceleration	1	9		0.9
19	Deceleration		9	1	1.1
20	Idle-Acceleration		8	2	1.2
21	Idle-Acceleration		10		1.0
22	Deceleration		10		1.0
23	Idle-Acceleration		8	2	1.2
24	Deceleration	1	8	1	1.0

TABLE 39E. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("P" Pungent Standard)

Vehicle: Bus 683
Date: January 24, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses			
		0	1	2	Avg
1	20 mph at 40 hp		10		1.0
2	40 mph at 40 hp		9	1	1.1
3	30 mph at 40 hp		10		1.0
4	Idle		10		1.0
5	20 mph at 40 hp		7	3	1.3
6	30 mph at 40 hp		9	1	1.1
7	40 mph at 40 hp		9	1	1.1
8	Idle		9	1	1.1
9	40 mph at 40 hp		10		1.0
10	30 mph at 40 hp		10		1.0
11	Idle		10		1.0
12	20 mph at 40 hp		7	3	1.3
13	20 mph at 40 hp		8	2	1.2
14	30 mph at 40 hp		10		1.0
15	Idle	1	9		0.9
16	40 mph at 40 hp		9	1	1.1
17	Deceleration	2	8		0.8
18	Idle-Acceleration		8	2	1.2
19	Deceleration		9	1	1.1
20	Idle-Acceleration		9	1	1.1
21	Idle-Acceleration	1	8	1	1.0
22	Deceleration	3	7		0.7
23	Idle-Acceleration		10		1.0
24	Deceleration		10		1.0

TABLE 40. COMPARISON OF SMOKE READINGS FOR STOCK MUFFLER AND CATALYTIC MUFFLER "V" INSTALLED

Vehicle: Bus 683
Date: January 23 and 24, 1969

Operating Conditions: See Table 7
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (All open-rack, maximum output)

Type Operation	Vehicle Speed, mph	Load hp	PHS Smoke Readings, Percent Opacity Max	Min	Avg
A. Stock	20	42	13	11	11.7
"V"	20	43	14	13	13.7
Net Change					+2.0
B. Stock	25	55	9	8	8.3
"V"	25	57	10	10	10.0
Net Change					+2.3
C. Stock	30	65	7	6	6.7
"V"	30	69	8	7	7.7
Net Change					+1.0
D. Stock	35	77	7	6	6.5
"V"	35	78	7	7	7.0
Net Change					+0.5

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity Max	Min	Avg
Start of Engine			
Stock	8	6	6.7
"V"	8	7	7.3
Net Change			+0.6
During Acceleration			
Stock	5	4	4.3
"V"	9	8	8.5
Net Change			+4.2
After Upshift			
Stock	4.5	4.5	4.5
"V"	9	8	8.7
Net Change			+4.2

TABLE 41 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS CATALYTIC MUFFLER CODE "V" VS STOCK MUFFLER

Vehicle: Bus 683
Date: January 23 and 24, 1969

Operating Conditions: See Table 10
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes*, ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		SO_2, ppm		Adjusting Factor	
	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"	Stock	"V"
I 20 mph 40 hp	1310	390	4.0	4.8	1,740	394	5.1	1.5	33.7	8.8	20.0	2.2	877	889	910	790	0.51	1.04		
	1665	163	4.0	4.0	1,902	510	6.3	2.1	37.0	12.6	18.7	3.2	773	854	910	870	0.17	0.70		
	990	182	3.6	4.1	2,327	464	5.3	1.4	24.9	10.4	18.0	2.3	900	900	870	900	0.51	0.19		
	1270	182	3.8	4.3	2,018	418	5.4	1.3	31.6	10.7	16.8	2.3	808	877	825	900	0.73	0.24		
"As-measured" Average	1309	229	3.9	4.2	1,997	447	5	1	31	10	18	2	840	880	879	865	0.4	0.5		
Adjusted Average†	4869	813	15.51	14.91	7,429	1587	20	5	118	37	68	9	3125	3126	3270	3071	1.79	1.9	3.72	3.55
II 30 mph 40 hp	250	148	3.2	3.7	1,717	719	3.6	0.9	27.8	15.0	7.2	2.2	912	1027	910	940	0.18	0.84		
	288	148	3.3	3.4	1,995	580	3.9	1.1	32.3	12.3	13.4	3.1	1016	970	870	940	0.21	0.90		
	288	148	3.3	3.3	2,188	719	2.8	0.7	30.6	11.4	12.0	2.3	935	900	910	900	0.29	0.13		
	288	148	3.2	3.6	2,304	742	3.6	1.0	29.4	12.8	11.5	1.6	935	912	910	900	0.48	1.22		
"As-measured" Average	279	148	3.3	3.5	2,051	690	3	1	30	12	11	2	949	952	900	920	0.2	0.7		
Adjusted Average	1256	632	14.85	14.95	9,230	2946	15	4	135	55	49	10	4274	4068	4050	3928	1.31	3.2	4.5	4.27
III 40 mph 40 hp	250	163	3.8	3.6	1,670	812	2.2	0.6	26.4	11.9	9.2	2.2	912	866	870	825	0.63	0.28		
	234	163	3.3	3.4	1,843	603	2.3	0.6	20.0	14.6	7.2	3.1	924	739	790	825	0.20	0.17		
	234	148	3.4	3.8	1,740	650	3.2	0.7	16.2	12.6	4.6	2.4	773	808	825	825	0.30	0.23		
	250	148	3.3	3.4	1,856	650	2.3	0.8	16.6	9.6	3.9	2.3	877	889	790	825	0.58	0.15		
"As-measured" Average	242	156	3.5	3.5	1,777	679	2	1	19	12	6	2	872	825	819	825	0.4	0.2		
Adjusted Average	1031	665	14.91	14.91	7,570	2893	10	3	84	51	26	10	3714	3518	3489	3515	1.83	0.8	4.26	4.26
IV Idle	270	236	0.5	0.8	650	325	2.7	1.4	30.9	16.0	11.7	4.5	300	346	320	350	0.22	0.46		
	250	251	0.6	0.8	626	371	2.9	1.3	25.4	16.4	8.4	5.4	346	323	320	380	0.24	0.64		
	250	236	0.7	0.8	542	348	3.2	1.4	27.8	15.4	5.4	4.6	242	334	320	380	0.26	0.63		
	250	236	0.7	0.8	626	371	3.9	1.1	26.4	14.9	9.6	4.8	300	277	350	350	0.26	0.68		
"As-measured" Average	255	240	0.6	0.8	611	354	3	1	27	15	8	4	297	320	328	365	0.2	0.6		
Adjusted Average	6120	4368	14.40	14.56	14,664	6443	77	24	663	286	211	89	7137	5833	7872	6643	6.00	10.9	24.0	18.2

---

*Total as ppm formaldehyde.

†Adjusted average values are based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" CO and CO_2 measurements.

TABLE 42. SUMMARY OF PRESSURE AND TEMPERATURE MEASUREMENTS CATALYTIC MUFFLER CODE "V" VS STOCK MUFFLER

Vehicle: Bus 683
Date: January 23 and 24, 1969

Operating Conditions: See Tables 11, 12, and 13
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Muffler Installed		Muffler Pressure, in. H_2O			Muffler Temperature °F			Air Box Pressure, in. Hg
			Inlet	Outlet	Differential	Inlet	Outlet	Differential	
I 20 mph 40 hp	Stock	Max	0.9	0.5	0.4	630	520	120	1.4
		Min	0.9	0.5	0.4	610	500	90	1.3
		Avg	0.9	0.5	0.4	620	510	113	1.4
	"V"	Max	1.6	1.2	0.4	630	558	72	1.9
		Min	1.6	1.2	0.4	575	538	37	1.9
		Avg	1.6	1.2	0.4	605	545	60	1.9
II 30 mph 40 hp	Stock	Max	1.5	0.8	0.7	600	500	100	2.8
		Min	1.4	0.8	0.6	590	500	90	2.7
		Avg	1.5	0.8	0.7	595	500	95	2.8
	"V"	Max	2.4	1.9	0.6	570	522	57	3.7
		Min	2.4	1.8	0.5	541	497	43	3.6
		Avg	2.4	1.8	0.6	555	506	49	3.6
III 40 mph 40 hp	Stock	Max	2.5	1.4	1.1	630	560	80	5.5
		Min	2.4	1.4	1.0	600	540	50	5.3
		Avg	2.5	1.4	1.1	618	550	68	5.5
	"V"	Max	4.0	3.0	1.0	642	601	45	6.6
		Min	3.9	3.0	0.9	567	524	40	6.4
		Avg	4.0	3.0	1.0	592	550	41	6.5
IV Idle	Stock	Max	0.2	0.2	0.1	300	350	(50)*	0.7
		Min	0.2	0.1	0	290	330	(40)	0.7
		Avg	0.2	0.1	0.1	298	345	(48)	0.7
	"V"	Max	0.4	0.3	0.2	323	293	33	0.8
		Min	0.4	0.2	0.1	274	267	3	0.6
		Avg	0.4	0.3	0.2	303	284	18	0.8

Air Box Pressures, Engine Under No Load

Engine, rpm	Stock Muffler, in. Hg	Catalytic Muffler, in. Hg	Reference-Min Pressure at Max Exhaust Pressure†
1200	2.9	3.2	
1800	6.4	7.3	
2100	9.5	10.5	

---

*Parentheses ( ) denote the inlet muffler temperature less than the outlet muffler temperature.
†From GMC Truck and Coach Division Diesel Engine Maintenance Manual X-6310.

TABLE 43. VEHICLE ODOR EVALUATION SUMMARY CATALYTIC MUFFLER CODE "U" INSTALLED

Vehicle: Bus 683
Date: March 11, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	20 mph at 40 hp	5.7	1.6	1.1	1.3	1.3
8	" "	6.2	2.0	1.4	1.3	1.2
12	" "	5.3	1.4	1.1	1.1	0.9
14	" "	5.8	1.8	1.4	1.2	1.0
		5.8	1.7	1.3	1.2	1.1
2	30 mph at 40 hp	5.8	1.7	1.3	1.2	1.1
5	" "	5.4	1.4	1.1	1.1	1.3
11	" "	5.3	1.7	1.1	1.0	1.0
13	" "	5.0	1.3	1.1	1.0	0.9
		5.4	1.5	1.2	1.1	1.1
1	40 mph at 40 hp	5.8	1.7	1.4	1.1	1.4
7	" "	5.0	1.4	1.3	1.2	1.0
9	" "	5.0	1.3	1.2	1.0	1.0
16	" "	5.4	1.7	1.2	1.1	0.9
		5.3	1.5	1.3	1.1	1.1
3	Idle	5.3	1.4	1.2	1.3	1.0
6	"	5.0	1.3	1.1	1.1	1.1
10	"	4.9	1.6	0.9	0.9	0.8
15	"	5.1	1.4	1.2	1.2	0.9
		5.1	1.4	1.1	1.1	1.0
19	Idle-Acceleration	6.0	1.9	1.7	1.2	0.9
21	" "	6.0	1.9	1.2	1.2	1.3
22	" "	5.9	1.9	1.3	1.1	1.3
24	" "	5.1	1.7	1.3	1.0	1.0
		5.8	1.9	1.4	1.1	1.1
17	Deceleration	5.0	1.4	1.1	1.0	1.0
18	"	4.1	1.1	1.0	1.1	0.8
20	"	4.6	1.2	1.1	1.0	0.8
23	"	5.2	1.6	1.3	1.1	1.0
		4.7	1.3	1.1	1.1	0.9

TABLE 43A. VEHICLE ODOR EVALUATION RESULTS-- "U" MUFFLER
("D" Diesel Composite Results)

Vehicle: Bus 683
Date: March 11, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses 3	4	5	6	7	Avg
1	40 mph at 40 hp			3	6	1	5.8
2	30 mph at 40 hp			3	6	1	5.8
3	Idle			7	3		5.3
4	20 mph at 40 hp			4	5	1	5.7
5	30 mph at 40 hp			6	4		5.4
6	Idle		1	8	1		5.0
7	40 mph at 40 hp		2	6	2		5.0
8	20 mph at 40 hp				8	2	6.2
9	40 mph at 40 hp			10			5.0
10	Idle		2	7	1		4.9
11	30 mph at 40 hp			7	3		5.3
12	20 mph at 40 hp			7	3		5.3
13	30 mph at 40 hp			10			5.0
14	20 mph at 40 hp			2	8		5.8
15	Idle			9	1		5.1
16	40 mph at 40 hp			6	4		5.4
17	Deceleration			10			5.0
18	Deceleration		9	1			4.1
19	Idle-Acceleration				10		6.0
20	Deceleration	2	1	6	1		4.6
21	Idle-Acceleration			1	8	1	6.0
22	Idle-Acceleration			2	7	1	5.9
23	Deceleration			8	2		5.2
24	Idle-Acceleration		2	5	3		5.1

TABLE 43B. VEHICLE ODOR EVALUATION RESULTS--"U" MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 683
Date: March 11, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Avg
1	40 mph at 40 hp	3	7		1.7
2	30 mph at 40 hp	3	7		1.7
3	Idle	6	4		1.4
4	20 mph at 40 hp	4	6		1.6
5	30 mph at 40 hp	6	4		1.4
6	Idle	7	3		1.3
7	40 mph at 40 hp	6	4		1.4
8	20 mph at 40 hp		10		2.0
9	40 mph at 40 hp	7	3		1.3
10	Idle	4	6		1.6
11	30 mph at 40 hp	3	7		1.7
12	20 mph at 40 hp	6	4		1.4
13	30 mph at 40 hp	7	3		1.3
14	20 mph at 40 hp	2	8		1.8
15	Idle	6	4		1.4
16	40 mph at 40 hp	3	7		1.7
17	Deceleration	6	4		1.4
18	Deceleration	9	1		1.1
19	Idle-Acceleration	1	9		1.9
20	Deceleration	8	2		1.2
21	Idle-Acceleration	1	9		1.9
22	Idle-Acceleration	2	7	1	1.9
23	Deceleration	4	6		1.6
24	Idle-Acceleration	3	7		1.7

TABLE 43C. VEHICLE ODOR EVALUATION RESULTS--"U" MUFFLER

("O" Oily Standard)

Vehicle: Bus 683
Date: March 11, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"O" Oily Responses			
		0	1	2	Avg
1	40 mph at 40 hp		6	4	1.4
2	30 mph at 40 hp		7	3	1.3
3	Idle		8	2	1.2
4	20 mph at 40 hp		9	1	1.1
5	30 mph at 40 hp		9	1	1.1
6	Idle		9	1	1.1
7	40 mph at 40 hp		7	3	1.3
8	20 mph at 40 hp		6	4	1.4
9	40 mph at 40 hp		8	2	1.2
10	Idle	3	5	2	0.9
11	30 mph at 40 hp	1	7	2	1.1
12	20 mph at 40 hp		9	1	1.1
13	30 mph at 40 hp		9	1	1.1
14	20 mph at 40 hp		6	4	1.4
15	Idle		8	2	1.2
16	40 mph at 40 hp		8	2	1.2
17	Deceleration		9	1	1.1
18	Deceleration	1	8	1	1.0
19	Idle-Acceleration		3	7	1.7
20	Deceleration		9	1	1.1
21	Idle-Acceleration		8	2	1.2
22	Idle-Acceleration		7	3	1.3
23	Deceleration		7	3	1.3
24	Idle-Acceleration		7	3	1.3

TABLE 43D. VEHICLE ODOR EVALUATION RESULTS--"U" MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 683
Date: March 11, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	40 mph at 40 hp	1	7	2	1.1
2	30 mph at 40 hp		8	2	1.2
3	Idle		7	3	1.3
4	20 mph at 40 hp		7	3	1.3
5	30 mph at 40 hp	1	7	2	1.1
6	Idle		9	1	1.1
7	40 mph at 40 hp		8	2	1.2
8	20 mph at 40 hp		7	3	1.3
9	40 mph at 40 hp		10		1.0
10	Idle	2	7	1	0.9
11	30 mph at 40 hp	1	8	1	1.0
12	20 mph at 40 hp		9	1	1.1
13	30 mph at 40 hp		10		1.0
14	20 mph at 40 hp		8	2	1.2
15	Idle		8	2	1.2
16	40 mph at 40 hp		9	1	1.1
17	Deceleration		10		1.0
18	Deceleration		9	1	1.1
19	Idle-Acceleration		8	2	1.2
20	Deceleration		10		1.0
21	Idle-Acceleration		8	2	1.2
22	Idle-Acceleration	1	7	2	1.1
23	Deceleration		9	1	1.1
24	Idle-Acceleration	1	8	1	1.0

TABLE 43E. VEHICLE ODOR EVALUATION RESULTS--"U" MUFFLER
("P" Pungent Standard)

Vehicle: Bus 683
Date: March 11, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	40 mph at 40 hp		6	4	1.4
2	30 mph at 40 hp		9	1	1.1
3	Idle		10		1.0
4	20 mph at 40 hp		7	3	1.3
5	30 mph at 40 hp		7	3	1.3
6	Idle		9	1	1.1
7	40 mph at 40 hp		10		1.0
8	20 mph at 40 hp		8	2	1.2
9	40 mph at 40 hp		10		1.0
10	Idle	4	5	1	0.8
11	30 mph at 40 hp	1	8	1	1.0
12	20 mph at 40 hp	1	9		0.9
13	30 mph at 40 hp	1	9		0.9
14	20 mph at 40 hp	2	6	2	1.0
15	Idle	1	9		0.9
16	40 mph at 40 hp	2	7	1	0.9
17	Deceleration		10		1.0
18	Deceleration	2	8		0.8
19	Idle-Acceleration	1	9		0.9
20	Deceleration	2	8		0.8
21	Idle-Acceleration		7	3	1.3
22	Idle-Acceleration		7	3	1.3
23	Deceleration		10		1.0
24	Idle-Acceleration		10		1.0

TABLE 44. VEHICLE ODOR EVALUATION SUMMARY STOCK MUFFLER INSTALLED

Vehicle: Bus 683
Date: March 12, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	5.0	1.6	1.1	1.1	1.0
5	" "	6.0	1.9	1.4	1.3	1.0
10	" "	5.7	2.0	1.2	1.1	0.9
15	" "	6.0	2.0	2.0	1.3	1.0
		5.7	1.9	1.4	1.2	1.0
1	30 mph at 40 hp	5.1	1.7	1.1	1.0	1.0
6	" "	5.0	1.3	1.3	0.9	0.9
11	" "	5.2	1.7	1.2	1.0	1.1
14	" "	5.6	1.8	1.7	1.2	1.0
		5.2	1.6	1.3	1.0	1.0
2	40 mph at 40 hp	4.9	1.7	1.2	1.2	1.0
7	" "	5.2	1.6	1.4	1.0	1.0
9	" "	5.7	1.7	1.4	1.3	0.8
13	" "	6.0	1.9	1.7	1.2	1.1
		5.5	1.7	1.4	1.2	1.0
4	Idle	5.7	1.8	1.3	1.3	1.1
8	"	5.7	1.8	1.4	1.2	1.1
12	"	6.0	2.0	1.7	1.3	1.1
16	"	5.4	1.9	1.8	1.0	1.0
		5.7	1.9	1.6	1.2	1.1
17	Idle-Acceleration	5.8	1.9	1.8	1.1	1.1
20	" "	6.1	2.2	1.7	1.1	1.0
22	" "	6.8	2.2	2.1	1.3	1.6
23	" "	6.4	2.0	1.9	1.6	1.0
		6.3	2.1	1.9	1.3	1.2
18	Deceleration	5.6	1.8	1.3	1.2	0.8
19	"	5.6	1.8	1.6	0.9	0.9
21	"	5.2	1.6	1.2	1.0	0.9
24	"	5.8	1.9	1.6	1.6	0.9
		5.6	1.8	1.4	1.2	0.9

TABLE 44A. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("D" Diesel Composite Results)

Vehicle: Bus 683
Date: March 12, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses				
		4	5	6	7	Avg
1	30 mph at 40 hp		9	1		5.1
2	40 mph at 40 hp	2	7	1		4.9
3	20 mph at 40 hp	2	6	2		5.0
4	Idle		3	7		5.7
5	20 mph at 40 hp			10		6.0
6	30 mph at 40 hp	3	4	3		5.0
7	40 mph at 40 hp	1	6	3		5.2
8	Idle		3	7		5.7
9	40 mph at 40 hp		3	7		5.7
10	20 mph at 40 hp		3	7		5.7
11	30 mph at 40 hp		8	2		5.2
12	Idle			10		6.0
13	40 mph at 40 hp			10		6.0
14	30 mph at 40 hp		4	6		5.6
15	20 mph at 40 hp			10		6.0
16	Idle		6	4		5.4
17	Idle-Acceleration		2	8		5.8
18	Deceleration		4	6		5.6
19	Deceleration		4	6		5.6
20	Idle-Acceleration			9	1	6.1
21	Deceleration		8	2		5.2
22	Idle-Acceleration			2	8	6.8
23	Idle-Acceleration			6	4	6.4
24	Deceleration		2	8		5.8

TABLE 44B. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("B" Burnt-Smoky Standard)

Vehicle: Bus 683	Operating Conditions: See Table 2
Date: March 12, 1969	Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses			
		1	2	3	Avg
1	30 mph at 40 hp	3	7		1.7
2	40 mph at 40 hp	3	7		1.7
3	20 mph at 40 hp	4	6		1.6
4	Idle	2	8		1.8
5	20 mph at 40 hp	1	9		1.9
6	30 mph at 40 hp	7	3		1.3
7	40 mph at 40 hp	4	6		1.6
8	Idle	2	8		1.8
9	40 mph at 40 hp	3	7		1.7
10	20 mph at 40 hp		10		2.0
11	30 mph at 40 hp	3	7		1.7
12	Idle		10		2.0
13	40 mph at 40 hp	1	9		1.9
14	30 mph at 40 hp	2	8		1.8
15	20 mph at 40 hp		10		2.0
16	Idle	1	9		1.9
17	Idle-Acceleration	1	9		1.9
18	Deceleration	3	6	1	1.8
19	Deceleration	3	6	1	1.8
20	Idle-Acceleration		8	2	2.2
21	Deceleration	4	6		1.6
22	Idle-Acceleration		8	2	2.2
23	Idle-Acceleration		10		2.0
24	Deceleration	1	9		1.9

TABLE 44C. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("O" Oily Standard)

Vehicle: Bus 683
Date: March 12, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"O" Oily Response 0	1	2	3	Avg
1	30 mph at 40 hp		9	1		1.1
2	40 mph at 40 hp		8	2		1.2
3	20 mph at 40 hp		9	1		1.1
4	Idle		7	3		1.3
5	20 mph at 40 hp		6	4		1.4
6	30 mph at 40 hp		7	3		1.3
7	40 mph at 40 hp	1	5	4		1.4
8	Idle		6	4		1.4
9	40 mph at 40 hp		6	4		1.4
10	20 mph at 40 hp		8	2		1.2
11	30 mph at 40 hp		8	2		1.2
12	Idle		3	7		1.7
13	40 mph at 40 hp		3	7		1.7
14	30 mph at 40 hp		3	7		1.7
15	20 mph at 40 hp			10		2.0
16	Idle		2	8		1.8
17	Idle-Acceleration		2	8		1.8
18	Deceleration		7	3		1.3
19	Deceleration		4	6		1.6
20	Idle-Acceleration		3	7		1.7
21	Deceleration		8	2		1.2
22	Idle-Acceleration			9	1	2.1
23	Idle-Acceleration		1	9		1.9
24	Deceleration		4	6		1.6

TABLE 44D. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("A" Aromatic Standard)

Vehicle: Bus 683
Date: March 12, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	2	Avg
1	30 mph at 40 hp		10		1.0
2	40 mph at 40 hp		8	2	1.2
3	20 mph at 40 hp	1	7	2	1.1
4	Idle		7	3	1.3
5	20 mph at 40 hp		7	3	1.3
6	30 mph at 40 hp	1	9		0.9
7	40 mph at 40 hp		10		1.0
8	Idle		8	2	1.2
9	40 mph at 40 hp		7	3	1.3
10	20 mph at 40 hp		9	1	1.1
11	30 mph at 40 hp		10		1.0
12	Idle		7	3	1.3
13	40 mph at 40 hp		8	2	1.2
14	30 mph at 40 hp		8	2	1.2
15	20 mph at 40 hp		7	3	1.3
16	Idle	1	8	1	1.0
17	Idle-Acceleration	1	7	2	1.1
18	Deceleration		8	2	1.2
19	Deceleration	2	7	1	0.9
20	Idle-Acceleration	1	7	2	1.1
21	Deceleration		10		1.0
22	Idle-Acceleration		7	3	1.3
23	Idle-Acceleration		4	6	1.6
24	Deceleration		4	6	1.6

TABLE 44E. VEHICLE ODOR EVALUATION RESULTS--STOCK MUFFLER

("P" Pungent Standard)

Vehicle: Bus 683
Date: March 12, 1969

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Avg
1	30 mph at 40 hp		10		1.0
2	40 mph at 40 hp		10		1.0
3	20 mph at 40 hp		10		1.0
4	Idle		9	1	1.1
5	20 mph at 40 hp		10		1.0
6	30 mph at 40 hp	2	7	1	0.9
7	40 mph at 40 hp		10		1.0
8	Idle		9	1	1.1
9	40 mph at 40 hp	2	8		0.8
10	20 mph at 40 hp	1	9		0.9
11	30 mph at 40 hp		9	1	1.1
12	Idle		9	1	1.1
13	40 mph at 40 hp		9	1	1.1
14	30 mph at 40 hp		10		1.0
15	20 mph at 40 hp		10		1.0
16	Idle		10		1.0
17	Idle-Acceleration		9	1	1.1
18	Deceleration	2	8		0.8
19	Deceleration	1	9		0.9
20	Idle-Acceleration	1	8	1	1.0
21	Deceleration	1	9		0.9
22	Idle-Acceleration		4	6	1.6
23	Idle-Acceleration		10		1.0
24	Deceleration	1	9		0.9

TABLE 45. COMPARISON OF SMOKE READINGS FOR STOCK MUFFLER AND CATALYTIC MUFFLER CODE "U"

Vehicle: Bus 683	Operating Conditions: See Table 7
Date: March 11 and 12, 1969	Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (All open-rack, maximum output)

	Type Operation	Vehicle Speed, mph	Load hp	PHS Smoke Readings, Percent Opacity		
				Max	Min	Avg
A.	Stock	20	42	13	13	13.0
	"U"	20	40	15	14	14.3
	Net Change					+1.3
B.	Stock	25	56	10	10	10.0
	"U"	25	56	10	9	9.3
	Net Change					+0.7
C.	Stock	30	70	8	8	8.0
	"U"	30	70	7	6	6.3
	Net Change					+1.7
D.	Stock	35	80	7	7	7.0
	"U"	35	82	6	5	5.3
	Net Change					-1.7

Transient Operation, Idle-Acceleration (40 hp at 30 mph preset and retained)

Portion of "E" Idle-Acceleration	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
Start of Engine			
Stock	10	10	10.0
"U"	7	7	7.0
Net Change			-3.0
During Acceleration			
Stock	7	6	6.7
"U"	11	11	11.0
Net Change			+4.3
After Upshift			
Stock	8	7	7.7
"U"	6	6	6.0
Net Change			-1.7

TABLE 46. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS CATALYTIC MUFFLER CODE "U" VS STOCK MUFFLER

Vehicle: Bus 683
Date: March 11 and 12, 1969

Operating Conditions: See Table 10
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO₂, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes,* ppm		Formaldehyde, ppm		NOx, ppm		NO, ppm		SO₂, ppm		Adjusting Factor	
	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"	Stock	"U"
I	1315	905	4.7	5.1	1740	928	4.4	3.4	37.2	19.2	15.4	10.2	681	843	790	825	0.25	0.33		
20 mph	1290	1390	4.8	4.8	1740	1114	4.8	3.0	39.5	17.0	15.4	9.8	854	843	790	825	0.25	0.36		
40 hp	1290	550	4.5	4.9	1763	928	4.5	2.8	31.7	19.8	13.4	10.2	750	843	730	870	0.25	0.32		
	1270	610	4.5	5.1	1786	882	3.2	3.0	28.2	23.8	12.8	9.8	773	843	750	870	0.26	0.32		
"As-measured" Average	1291	864	4.7	5.0	1757	958	4	3	34	20	14	10	765	843	765	848	0.2	0.3	3.11	2.96
Adjusted Average†	4015	2557	14.61	14.80	5464	2835	13	9	106	59	44	29	2379	2495	2379	2510	7	9		
II	305	200	3.8	3.8	1554	812	2.8	1.3	23.8	14.9	10.6	4.9	900	808	790	825	0.19	0.24		
30 mph	250	150	3.6	3.6	1624	905	3.3	1.4	25.9	18.5	12.8	6.6	866	820	720	825	0.22	0.26		
40 hp	180	235	3.2	3.6	1740	1160	2.8	1.2	19.7	20.8	8.5	5.2	912	796	720	825	0.24	0.30		
	200	150	3.6	3.8	1670	974	3.1	0.9	20.6	17.2	9.2	5.3	970	762	720	825	0.24	0.28		
"As-measured" Average	234	184	3.6	3.7	1647	963	3	1	22	17	10	5	912	796	738	825	0.2	0.2	4.14	4.03
Adjusted Average	968	741	14.90	14.91	6818	3881	12	5	93	68	42	22	3777	3211	3055	3324	9	1		
III	200	100	3.6	3.8	1462	626	1.6	0.9	26.2	19.6	8.3	4.9	843	727	720	750	0.18	0.26		
40 mph	200	165	3.2	3.2	1485	928	2.3	0.8	28.9	20.3	7.6	4.4	762	730	675	720	0.22	0.30		
40 hp	160	130	3.3	3.1	1508	858	2.2	1.1	23.2	24.0	6.3	6.8	866	727	720	720	0.21	0.28		
	150	180	3.1	3.4	1485	905	2.2	1.0	22.5	22.9	7.8	0.9	750	716	640	720	0.22	0.31		
"As-measured" Average	178	144	3.3	3.4	1460	829	2	1	25	21	7	4	805	730	689	728	0.2	0.2	4.51	4.40
Adjusted Average	803	633	14.88	14.96	6585	3647	9	4	113	95	34	18	3633	3214	3107	3203	0.9	1		
IV	290	80	0.9	1.2	464	162	3.5	0.7	27.8	15.9	10.5	4.2	254	288	250	280	0.19	0.24		
Idle	290	80	0.8	1.0	464	139	3.4	0.7	23.9	15.6	9.0	6.6	265	277	280	350	0.22	0.24		
	250	115	0.8	1.2	487	232	3.6	0.6	23.5	17.8	10.7	6.0	300	254	250	390	0.24	0.22		
	235	80	0.8	1.0	464	116	3.2	0.8	26.6	16.6	12.9	6.3	300	254	250	320	0.22	0.24		
"As-measured" Average	266	80	0.8	1.1	470	162	3	1	25	16	10	5	280	268	258	335	0.2	0.2	18.07	13.54
Adjusted Average	4806	1205	14.46	14.89	8492	2193	62	9	460	223	195	78	5061	3636	4662	4535	3	3		

---

*Total as ppm formaldehyde.

†Adjusted average is based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 47. SUMMARY OF PRESSURE AND TEMPERATURE MEASUREMENTS CATALYTIC MUFFLER CODE "U" VS STOCK MUFFLER

Vehicle: Bus 683
Date: March 11 & 12, 1969

Operating Conditions: See Tables 11, 12, & 13
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Muffler Installed		Muffler Pressure, in. Hg			Muffler Temperature °F			Air Box Pressures, in. Hg
			Inlet	Outlet	Differential	Inlet	Outlet	Differential	
I 20 mph 40 hp	Stock	Max	14.5	9.5	5.0	550	490	60	1.8
		Min	14.0	9.0	5.0	510	430	90	1.7
		Avg	14.1	9.1	5.0	528	465	63	1.8
	"U"	Max	10.0	4.5	5.5	‡	420		1.7
		Min	9.0	4.0	5.0		370		1.7
		Avg	9.3	4.1	5.1		405		1.7
II 30 mph 40 hp	Stock	Max	27.5	16.0	8.5	450	470	(30)*	3.6
		Min	26.5	17.0	8.5	410	430	(15)	3.6
		Avg	26.9	17.6	8.5	424	445	(21)	3.6
	"U"	Max	17.0	9.0	8.0		460		3.2
		Min	16.0	8.0	8.0		360		3.2
		Avg	16.3	8.6	8.0		423		3.2
III 40 mph 40 hp	Stock	Max	50.0	34.0	16.0	460	480	(50)	6.6
		Min	48.0	33.0	15.0	400	440	0	6.6
		Avg	49.0	33.5	15.3	431	455	(24)	6.6
	"U"	Max	30.0	16.0	13.0		430		5.7
		Min	27.0	14.0	12.0		400		5.7
		Avg	28.0	14.8	12.5		418		5.7
IV Idle	Stock	Max	2.5	2.0	1.0	200	300	(125)	0.9
		Min	2.5	2.0	0.5	175	280	(90)	0.9
		Avg	2.5	2.0	0.8	190	290	(100)	0.9
	"U"	Max	3.0	1.5	1.5		420		0.9
		Min	2.5	1.0	1.5		360		0.9
		Avg	2.6	1.1	1.5		393		0.9

Air Box Pressures, Engine Under No Load

Engine, rpm	Stock Muffler, in. Hg	Catalytic Muffler, in. Hg	Reference-Min Pressure at Max Exhaust Pressure†
1200	3.4	3.3	
1800	8.0	7.3	
2100	10.9	10.4	

---

*Parentheses ( ) denote the inlet muffler temperature less than the outlet temperature.
†From GMC Truck and Coach Division Diesel Engine Maintenance Manual X-6310, page 173.
‡Thermocouple inoperative.

APPENDIX C

MUNICIPAL BUS VARIABILITY RESULTS
Detroit Diesel 6V-71, N Type, Two-Cycle Engine

TABLE 1. LIST OF MUNICIPAL BUSES EVALUATED AND PERTINENT ENGINE MAINTENANCE HISTORY

Bus No.	Date Tested	Total Engine Miles	Miles Since Tune-up	For Odor Results See	For Smoke Results See
761	7/9/68	137,516	52,516	Table 3	Table 14
762	7/10/68	135,885	50,855	Table 4	Table 15
763	7/12/68	136,241	51,241	Table 5	Table 16
764	7/15/68	130,310	45,310	Table 6	Table 17
765	7/16/68	121,359	36,359	Table 7	Table 18
766	7/17/68	135,220	50,220	Table 8	Table 19
767	7/18/68	132,664	47,664	Table 9	Table 20
768	7/19/68	132,598	47,598	Table 10	Table 21
769	7/22/68	124,924	39,924	Table 11	Table 22
770	7/23/68	133,768	48,768	Table 12	Table 23

Maintenance Notes

The above vehicles were part of a group of thirty units delivered in April 1966. A routine engine tune-up was performed at 85,000 miles, which did not include injector change. As of the date of test, no injector changes had been made, these changes are scheduled at 170,000 miles. All units had a valve job, however, as part of the addition of the Jacobs Engine Brake in February 1968.

TABLE 2. ODOR EVALUATION CONDITIONS EMPLOYED DURING STUDY OF VEHICLE VARIABILITY

Vehicle Data:	GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 N series, two-valve engine. Muffler under coach. Air-conditioning rack compensator removed. For vehicles equipped with Jacobs retarders, the retarder is not operated.
Sampling Data:	Constant sample flow at 100:1 dilution level.
Inertia:	Full inertia simulation via SwRI system.

OPERATING CONDITIONS

Type Operation	Vehicle Speed, mph	Vehicle Load, hp	For Details Refer to:
I. Constant Speed	20	40	Table 3 of Appendix B
II. Constant Speed	40	40	Table 3 of Appendix B
III. Constant Speed-Idle	--	--	Table 4 of Appendix B
IV. Idle-Acceleration	0-20	0	Table 5 of Appendix B
V. Constant Speed-Deceleration	40-0	40 hp at 40 mph	Table 6 of Appendix B

TABLE 3. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	 "B" Burnt	 "O" Oily	 "A" Aromatic	 "P" Pungent
8	I. Constant Speed	5.0	1.1	1.1	0.8	0.5
11	" "	6.0	1.8	1.2	1.0	0.8
20	" "	6.1	1.9	1.6	1.1	1.0
24	" "	6.2	1.9	1.6	0.9	0.8
		5.8	1.7	1.4	0.9	0.8
1	II. Constant Speed	5.7	1.6	1.4	1.1	0.6
5	" "	5.5	1.4	1.3	0.9	0.6
17	" "	6.5	2.0	1.7	1.3	0.8
21	" "	5.7	2.0	1.3	0.8	0.6
		5.9	1.8	1.4	1.0	0.9
3	III. Idle	5.1	1.3	1.0	0.9	0.9
6	"	4.6	1.1	1.0	0.8	0.4
14	"	5.0	1.4	1.0	0.8	0.8
16	"	5.8	2.0	1.2	1.1	1.0
		5.1	1.5	1.0	0.9	1.0
2	IV. Idle-Acceleration	6.7	2.1	1.4	1.0	1.0
9	" "	5.4	2.0	1.3	0.9	0.8
19	" "	6.4	2.1	1.7	1.1	1.2
22	" "	6.3	1.9	1.6	1.0	1.0
		6.2	2.0	1.5	1.0	1.0
4	V. Deceleration	4.1	1.0	1.0	0.8	0.4
10	"	4.8	1.4	1.0	1.0	0.5
13	"	5.4	1.7	1.2	0.8	0.7
23	"	4.9	1.1	1.0	0.8	0.6
		4.8	1.3	1.0	0.9	0.6

---

*Runs 7, 12, 15, and 18 were conducted without exhaust sample.

TABLE 3A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses					
		0	4	5	6	7	Average
1	Constant Speed			3	7		5.7
2	Idle-Acceleration				3	7	6.7
3	Idle		1	7	2		5.1
4	Deceleration		9	1			4.1
5	Constant Speed			5	5		5.5
6	Idle		5	4	1		4.6
7	Blank	10					0
8	Constant Speed		2	6	2		5.0
9	Idle-Acceleration		1	4	5		5.4
10	Deceleration		4	4	2		4.8
11	Constant Speed			2	6	2	6.0
12	Blank	10					0
13	Deceleration		2	2	6		5.4
14	Idle		2	6	2		5.0
15	Blank	10					0
16	Idle			3	6	1	5.8
17	Constant Speed				5	5	6.5
18	Blank	10					0
19	Idle-Acceleration				6	4	6.4
20	Constant Speed			1	7	2	6.1
21	Constant Speed			3	7		5.7
22	Idle-Acceleration			1	5	4	6.3
23	Deceleration		2	7	1		4.9
24	Constant Speed				8	2	6.2

TABLE 3B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		4	6		1.6
2	Idle-Acceleration			9	1	2.1
3	Idle		7	3		1.3
4	Deceleration		10			1.0
5	Constant Speed		6	4		1.4
6	Idle		9	1		1.1
7	Blank	10				0
8	Constant Speed		9	1		1.1
9	Idle-Acceleration		4	6		2.0
10	Deceleration		6	4		1.4
11	Constant Speed		2	8		1.8
12	Blank	10				0
13	Deceleration		3	7		1.7
14	Idle		6	4		1.4
15	Blank	10				0
16	Idle		4	6		2.0
17	Constant Speed			10		2.0
18	Blank	10				0
19	Idle-Acceleration			9	1	2.1
20	Constant Speed		1	9		1.9
21	Constant Speed		4	6		2.0
22	Idle-Acceleration		1	9		1.9
23	Deceleration		9	1		1.1
24	Constant Speed		1	9		1.9

TABLE 3C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		6	4	1.4
2	Idle-Acceleration		6	4	1.4
3	Idle		10		1.0
4	Deceleration		10		1.0
5	Constant Speed		7	3	1.3
6	Idle		10		1.0
7	Blank	10			0
8	Constant Speed		9	1	1.1
9	Idle-Acceleration		7	3	1.3
10	Deceleration		10		1.0
11	Constant Speed		8	2	1.2
12	Blank	10			0
13	Deceleration		8	2	1.2
14	Idle		10		1.0
15	Blank	10			0
16	Idle		8	2	1.2
17	Constant Speed		3	7	1.7
18	Blank	10			0
19	Idle-Acceleration		3	7	1.7
20	Constant Speed		4	6	1.6
21	Constant Speed		7	3	1.3
22	Idle-Acceleration		4	6	1.6
23	Deceleration		10		1.0
24	Constant Speed		4	6	1.6

TABLE 3D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Average
1	Constant Speed		9	1	1.1
2	Idle-Acceleration		10		1.0
3	Idle	1	9		0.9
4	Deceleration	2	8		0.8
5	Constant Speed	1	9		0.9
6	Idle	2	8		0.8
7	Blank	10			0
8	Constant Speed	2	8		0.8
9	Idle-Acceleration	1	9		0.9
10	Deceleration		10		1.0
11	Constant Speed	1	8	1	1.0
12	Blank	10			0
13	Deceleration	3	6	1	0.8
14	Idle	2	8		0.8
15	Blank	10			0
16	Idle		9	1	1.1
17	Constant Speed		7	3	1.3
18	Blank	10			0
19	Idle-Acceleration		9	1	1.1
20	Constant Speed	1	7	2	1.1
21	Constant Speed	2	8		0.8
22	Idle-Acceleration		10		1.0
23	Deceleration	2	8		0.8
24	Constant Speed	1	9		0.9

TABLE 3E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	4	6		0. 6
2	Idle-Acceleration	1	8	1	1. 0
3	Idle	1	9		0. 9
4	Deceleration	6	4		0. 4
5	Constant Speed	4	6		0. 6
6	Idle	6	4		0. 4
7	Blank	10			0
8	Constant Speed	5	5		0. 5
9	Idle-Acceleration	2	8		0. 8
10	Deceleration	5	5		0. 5
11	Constant Speed	3	6	1	0. 8
12	Blank	10			0
13	Deceleration	3	7		0. 7
14	Idle	2	8		0. 8
15	Blank	10			0
16	Idle		10		1. 0
17	Constant Speed	3	6	1	0. 8
18	Blank	10			0
19	Idle-Acceleration		8	2	1. 2
20	Constant Speed	2	6	2	1. 0
21	Constant Speed	4	6		0. 6
22	Idle-Acceleration	1	8	1	1. 0
23	Deceleration	4	6		0. 6
24	Constant Speed	2	8		0. 8

TABLE 4. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 762
Date: July 10, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	I. Constant Speed	4.9	1.2	0.9	1.0	0.6
8	" "	4.5	1.3	1.0	0.8	0.7
14	" "	5.5	1.4	1.3	1.3	0.8
22	" "	5.3	1.3	1.1	0.7	0.6
		5.1	1.3	1.1	1.0	0.7
1	II. Constant Speed	5.1	1.4	1.0	0.9	0.6
7	" "	5.4	1.6	1.2	0.9	0.7
10	" "	5.9	1.9	1.2	1.3	1.0
24	" "	5.0	1.4	1.2	0.9	0.6
		5.4	1.6	1.2	1.0	0.7
4	III. Idle	5.2	1.4	1.1	1.0	0.7
11	"	5.6	1.8	1.4	0.9	1.1
18	"	4.4	1.1	1.0	1.0	0.4
23	"	4.9	1.5	1.1	0.9	0.3
		5.0	1.5	1.2	1.0	0.6
6	IV. Idle-Acceleration	6.0	1.9	1.4	0.8	1.3
13	" "	7.0	2.0	1.8	1.2	1.4
17	" "	6.6	2.0	1.7	1.0	1.0
21	" "	6.0	1.8	1.6	1.2	1.0
		6.4	1.9	1.6	1.1	1.2
5	V. Deceleration	6.2	1.9	1.6	1.0	1.0
15	"	5.6	1.8	1.6	1.3	1.2
19	"	6.2	2.0	1.5	1.0	1.1
20	"	6.7	2.0	1.7	1.1	1.3
		6.2	1.9	1.6	1.1	1.2

---

*Runs 3, 9, 12, and 16 were conducted without exhaust sample.

TABLE 4A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 762
Date: July 10, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses					
		0	4	5	6	7	Average
1	Constant Speed			9	1		5.1
2	Constant Speed		2	7	1		4.9
3	Blank	10					0
4	Idle		1	6	3		5.2
5	Deceleration				8	2	6.2
6	Idle-Acceleration			1	8	1	6.0
7	Constant Speed			7	2	1	5.4
8	Constant Speed		6	3	1		4.5
9	Blank	10					0
10	Constant Speed			1	9		5.9
11	Idle		1	3	5	1	5.6
12	Blank	10					0
13	Idle-Acceleration					10	7.0
14	Constant Speed			5	5		5.5
15	Deceleration			4	6		5.6
16	Blank	10					0
17	Idle-Acceleration				4	6	6.6
18	Idle		7	2	1		4.4
19	Deceleration			1	6	3	6.2
20	Deceleration				3	7	6.7
21	Idle-Acceleration			2	6	2	6.0
22	Constant Speed		1	5	4		5.3
23	Idle		3	5	2		4.9
24	Constant Speed		4	3	2	1	5.0

TABLE 4B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 762
Date: July 10, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	Average
1	Constant Speed		6	4	1.4
2	Constant Speed		8	2	1.2
3	Blank	10			0
4	Idle		6	4	1.4
5	Deceleration		1	9	1.9
6	Idle-Acceleration		2	8	1.8
7	Constant Speed		4	6	1.6
8	Constant Speed		7	3	1.3
9	Blank	10			0
10	Constant Speed		1	9	1.9
11	Idle		2	8	1.8
12	Blank	10			0
13	Idle-Acceleration			10	2.0
14	Constant Speed		6	4	1.4
15	Deceleration		2	8	1.8
16	Blank	10			0
17	Idle-Acceleration			10	2.0
18	Idle		9	1	1.1
19	Deceleration			10	2.0
20	Deceleration			10	2.0
21	Idle-Acceleration		2	8	1.8
22	Constant Speed		7	3	1.3
23	Idle		5	5	1.5
24	Constant Speed		6	4	1.4

TABLE 4C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 762
Date: July 10, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		10		1.0
2	Constant Speed	1	9		0.9
3	Blank	10			0
4	Idle		9	1	1.1
5	Deceleration		4	6	1.6
6	Idle-Acceleration	1	4	5	1.4
7	Constant Speed		8	2	1.2
8	Constant Speed		10		1.0
9	Blank	10			0
10	Constant Speed		8	2	1.2
11	Idle		6	4	1.4
12	Blank	10			0
13	Idle-Acceleration		2	8	1.8
14	Constant Speed		7	3	1.3
15	Deceleration	1	2	7	1.6
16	Blank	10			0
17	Idle-Acceleration		3	7	1.7
18	Idle		10		1.0
19	Deceleration		5	5	1.5
20	Deceleration		3	7	1.7
21	Idle-Acceleration		4	6	1.6
22	Constant Speed		9	1	1.1
23	Idle		9	1	1.1
24	Constant Speed		8	2	1.2

TABLE 4D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 762
Date: July 10, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	1	9		0.9
2	Constant Speed		10		1.0
3	Blank	10			0
4	Idle		10		1.0
5	Deceleration		10		1.0
6	Idle-Acceleration	3	6	1	0.8
7	Constant Speed	2	7	1	0.9
8	Constant Speed	2	8		0.8
9	Blank	10			0
10	Constant Speed		7	3	1.3
11	Idle	1	9		0.9
12	Blank	10			0
13	Idle-Acceleration		8	2	1.2
14	Constant Speed		7	3	1.3
15	Deceleration		7	3	1.3
16	Blank	10			0
17	Idle-Acceleration	1	8	1	1.0
18	Idle	2	8		1.0
19	Deceleration	1	8	1	1.0
20	Deceleration	1	7	2	1.1
21	Idle-Acceleration		8	2	1.2
22	Constant Speed	3	7		0.7
23	Idle	1	9		0.9
24	Constant Speed	1	9		0.9

TABLE 4E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 762
Date: July 10, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	4	6		0.6
2	Constant Speed	3	7		0.7
3	Blank	10			0
4	Idle	3	7		0.7
5	Deceleration	1	8	1	1.0
6	Idle-Acceleration	1	5	4	1.3
7	Constant Speed	4	5	1	0.7
8	Constant Speed	3	7		0.7
9	Blank	10			0
10	Constant Speed		10		1.0
11	Idle	2	5	3	1.1
12	Blank	10			0
13	Idle-Acceleration		6	4	1.4
14	Constant Speed	2	8		0.8
15	Deceleration		8	2	1.2
16	Blank	10			0
17	Idle-Acceleration	2	6	2	1.0
18	Idle	6	4		0.4
19	Deceleration	1	7	2	1.1
20	Deceleration		7	3	1.3
21	Idle-Acceleration	2	6	2	1.0
22	Constant Speed	4	6		0.6
23	Idle	7	3		0.3
24	Constant Speed	5	4	1	0.6

TABLE 5. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No. *	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
6	I. Constant Speed	5.3	1.5	1.1	1.0	0.7
8	" "	5.7	1.5	1.1	1.0	0.2
12	" "	6.1	1.9	1.2	0.9	0.5
20	" "	5.3	1.4	1.0	1.0	0.2
25	" "	6.0	1.4	1.2	0.9	0.8
		5.7	1.5	1.1	1.0	0.6
2	II. Constant Speed	5.4	1.3	1.1	0.8	0.4
14	" "	5.6	1.8	1.1	1.0	0.8
17	" "	5.3	1.3	1.2	1.0	0.4
23	" "	5.1	1.7	1.5	1.1	0.7
		5.4	1.5	1.2	1.0	0.6
5	III. Idle	5.2	1.4	1.0	0.8	0.8
13	"	5.1	1.1	1.0	0.9	0.8
18	"	4.8	1.1	1.0	1.0	0.6
22	"	5.0	1.2	1.1	1.0	1.0
		5.0	1.2	1.0	0.9	0.8
4	IV. Idle-Acceleration	6.1	1.9	1.5	1.0	0.6
10	" "	5.5	1.9	1.6	1.0	0.9
15	" "	6.0	1.7	1.4	0.8	0.7
24	" "	6.0	2.0	1.7	1.2	1.3
		5.9	1.9	1.6	1.0	0.9
1	V. Deceleration	5.7	1.6	1.1	0.8	0.3
9	"	4.7	1.0	0.9	0.8	0.1
16	"	5.8	1.5	1.3	1.1	0.3
21	"	5.4	1.5	1.2	1.0	0.9
		5.4	1.4	1.1	0.9	0.4

---

*Runs 3, 7, 11, and 14 were conducted without exhaust sample.

TABLE 5A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses					
		0	4	5	6	7	Average
1	Deceleration		2	2	3	3	5.7
2	Constant Speed			6	4		5.4
3	Blank	10					0
4	Idle-Acceleration			1	7	2	6.1
5	Idle			8	2		5.2
6	Constant Speed		1	5	4		5.3
7	Blank	10					0
8	Constant Speed			3	7		5.7
9	Deceleration		3	7			4.7
10	Idle-Acceleration			5	5		5.5
11	Blank	10					0
12	Constant Speed				9	1	6.1
13	Idle			9	1		5.1
14	Constant Speed			4	6		5.6
15	Idle-Acceleration			2	6	2	6.0
16	Deceleration		2	2	2	4	5.8
17	Constant Speed		1	5	4		5.3
18	Idle		2	8			4.8
19	Blank	10					0
20	Constant Speed		1	5	4		5.3
21	Deceleration		1	4	5		5.4
22	Idle			10			5.0
23	Constant Speed			9	1		5.1
24	Idle-Acceleration				2	8	6.8
25	Constant Speed			1	8	1	6.0

TABLE 5B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses			
		0	1	2	Average
1	Deceleration		4	6	1.6
2	Constant Speed		7	3	1.3
3	Blank	10			0
4	Idle-Acceleration		1	9	1.9
5	Idle		6	4	1.4
6	Constant Speed		5	5	1.5
7	Blank	10			0
8	Constant Speed		5	5	1.5
9	Deceleration		10		1.0
10	Idle-Acceleration		1	9	1.9
11	Blank	10			0
12	Constant Speed		1	9	1.9
13	Idle		9	1	1.1
14	Constant Speed		2	8	1.8
15	Idle-Acceleration		3	7	1.7
16	Deceleration		5	5	1.5
17	Constant Speed		7	3	1.3
18	Idle		9	1	1.1
19	Blank	10			0
20	Constant Speed		6	4	1.4
21	Deceleration		5	5	1.5
22	Idle		8	2	1.2
23	Constant Speed		3	7	1.7
24	Idle-Acceleration			10	2.0
25	Constant Speed		6	4	1.4

TABLE 5C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses			
		0	1	2	Average
1	Deceleration	2	5	3	1.1
2	Constant Speed		9	1	1.1
3	Blank	10			0
4	Idle-Acceleration		5	5	1.5
5	Idle	1	8	1	1.0
6	Constant Speed		9	1	1.1
7	Blank	10			0
8	Constant Speed		9	1	1.1
9	Deceleration	1	9		0.9
10	Idle-Acceleration		4	6	1.6
11	Blank	10			0
12	Constant Speed	1	6	3	1.2
13	Idle		10		1.0
14	Constant Speed		9	1	1.1
15	Idle-Acceleration		6	4	1.4
16	Deceleration		7	3	1.3
17	Constant Speed		8	2	1.2
18	Idle		10		1.0
19	Blank	10			0
20	Constant Speed	2	6	2	1.0
21	Deceleration		8	2	1.2
22	Idle		9	1	1.1
23	Constant Speed		5	5	1.5
24	Idle-Acceleration		3	7	1.7
25	Constant Speed		8	2	1.2

TABLE 5D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Deceleration	2	8		0.8
2	Constant Speed	2	8		0.8
3	Blank	10			0
4	Idle-Acceleration		10		1.0
5	Idle	2	8		0.8
6	Constant Speed		10		1.0
7	Blank	10			0
8	Constant Speed		10		1.0
9	Deceleration	2	8		0.8
10	Idle-Acceleration		10		1.0
11	Blank	10			0
12	Constant Speed	1	9		0.9
13	Idle	1	9		0.9
14	Constant Speed		10		1.0
15	Idle-Acceleration	2	8		0.8
16	Deceleration	1	7	2	1.1
17	Constant Speed		10		1.0
18	Idle		10		1.0
19	Blank	10			0
20	Constant Speed		10		1.0
21	Deceleration		10		1.0
22	Idle		10		1.0
23	Constant Speed		9	1	1.1
24	Idle-Acceleration		8	2	1.2
25	Constant Speed	1	9		0.9

TABLE 5E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Deceleration	7	3		0. 3
2	Constant Speed	6	4		0. 4
3	Blank	10			0
4	Idle-Acceleration	4	6		0. 6
5	Idle	2	8		0. 8
6	Constant Speed	3	7		0. 7
7	Blank	10			0
8	Constant Speed	8	2		0. 2
9	Deceleration	9	1		0. 1
10	Idle-Acceleration	1	9		0. 9
11	Blank	10			0
12	Constant Speed	5	5		0. 5
13	Idle	2	8		0. 8
14	Constant Speed	2	8		0. 8
15	Idle-Acceleration	3	7		0. 7
16	Deceleration	7	3		0. 3
17	Constant Speed	6	4		0. 4
18	Idle	4	6		0. 6
19	Blank	10			0
20	Constant Speed	8	2		0. 2
21	Deceleration	1	9		0. 9
22	Idle		10		1. 0
23	Constant Speed	3	7		0. 7
24	Idle-Acceleration		7	3	1. 3
25	Constant Speed	2	8		0. 8

TABLE 6. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	I. Constant Speed	5.6	1.6	1.3	1.1	0.7
7	" "	6.6	1.9	1.5	1.3	1.3
13	" "	5.9	1.8	1.4	1.2	0.9
18	" "	5.9	1.7	1.4	1.0	1.1
		6.0	1.8	1.4	1.2	1.0
2	II. Constant Speed	5.6	1.7	1.3	0.7	0.9
11	" "	4.1	1.4	1.1	1.1	0.7
16	" "	5.7	1.6	1.3	1.0	0.8
22	" "	5.3	1.5	1.2	0.7	0.8
		5.2	1.6	1.2	0.9	0.8
6	III. Idle	4.6	1.1	1.1	0.9	0.6
8	"	4.8	1.3	1.1	0.9	0.8
19	"	5.2	1.5	1.4	1.0	0.7
24	"	5.6	1.4	1.2	1.0	0.8
		5.1	1.4	1.2	1.0	0.7
4	IV. Idle-Acceleration	6.5	1.7	1.5	1.1	1.1
12	" "	7.0	1.9	1.7	1.2	1.2
17	" "	6.3	1.8	1.7	1.0	1.1
23	" "	6.8	2.2	1.8	1.2	1.4
		6.7	1.9	1.7	1.1	1.2
1	V. Deceleration	4.5	1.1	1.1	1.0	0.5
9	"	4.5	1.3	1.1	0.7	0.6
14	"	4.3	1.1	1.0	0.8	0.2
21	"	4.8	1.3	1.1	1.0	0.8
		4.5	1.2	1.1	0.9	0.5

---

*Runs 5, 10, 15, and 20 were conducted without exhaust sample.

TABLE 6A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses							
		0	3	4	5	6	7	8	Average
1	Deceleration		1	3	6				4.5
2	Constant Speed				4	6			5.6
3	Constant Speed			1	2	7			5.6
4	Idle-Acceleration				1	3	6		6.5
5	Blank	10							0
6	Idle			4	6				4.6
7	Constant Speed					4	6		6.6
8	Idle			3	6	1			4.8
9	Deceleration		1	5	2	2			4.5
10	Blank	10							0
11	Constant Speed		2	5	3				4.1
12	Idle-Acceleration						10		7.0
13	Constant Speed				1	9			5.9
14	Deceleration			7	3				4.3
15	Blank	10							0
16	Constant Speed			1	3	4	2		5.7
17	Idle-Acceleration					7	3		6.3
18	Constant Speed				2	7	1		5.9
19	Idle			2	5	2	1		5.2
20	Blank	10							0
21	Deceleration			3	6	1			4.8
22	Constant Speed				7	3			5.3
23	Idle-Acceleration					3	6	1	6.8
24	Idle			1	2	7			5.6

TABLE 6B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Deceleration		9	1		1.1
2	Constant Speed		3	7		1.7
3	Constant Speed		4	6		1.6
4	Idle-Acceleration		3	7		1.7
5	Blank	10				0
6	Idle		9	1		1.1
7	Constant Speed		1	9		1.9
8	Idle		7	3		1.3
9	Deceleration		7	3		1.3
10	Blank	10				0
11	Constant Speed		6	4		1.4
12	Idle-Acceleration		1	9		1.9
13	Constant Speed		2	8		1.8
14	Deceleration		9	1		1.1
15	Blank	10				0
16	Constant Speed		4	6		1.6
17	Idle-Acceleration		2	8		1.8
18	Constant Speed		3	7		1.7
19	Idle		5	5		1.5
20	Blank	10				0
21	Deceleration		7	3		1.3
22	Constant Speed		5	5		1.5
23	Idle-Acceleration			8	2	2.2
24	Idle		6	4		1.4

TABLE 6C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Deceleration		9	1	1. 1
2	Constant Speed		7	3	1. 3
3	Constant Speed		7	3	1. 3
4	Idle-Acceleration		5	5	1. 5
5	Blank	10			0
6	Idle		9	1	1. 1
7	Constant Speed		5	5	1. 5
8	Idle	1	7	2	1. 1
9	Deceleration		9	1	1. 1
10	Blank	10			0
11	Constant Speed		9	1	1. 1
12	Idle-Acceleration		3	7	1. 7
13	Constant Speed		6	4	1. 4
14	Deceleration	1	8	1	1. 0
15	Blank	10			0
16	Constant Speed		7	3	1. 3
17	Idle-Acceleration		3	7	1. 7
18	Constant Speed		6	4	1. 4
19	Idle		6	4	1. 4
20	Blank	10			0
21	Deceleration		9	1	1. 1
22	Constant Speed		8	2	1. 2
23	Idle-Acceleration		2	8	1. 8
24	Idle		8	2	1. 2

TABLE 6D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Deceleration		10		1. 0
2	Constant Speed	3	7		0. 7
3	Constant Speed	1	7	2	1. 1
4	Idle-Acceleration		9	1	1. 1
5	Blank	10			0
6	Idle	1	9		0. 9
7	Constant Speed		7	3	1. 3
8	Idle	1	9		0. 9
9	Deceleration	3	7		0. 7
10	Blank	10			0
11	Constant Speed		9	1	1. 1
12	Idle-Acceleration		8	2	1. 2
13	Constant Speed		8	2	1. 2
14	Deceleration	2	8		0. 8
15	Blank	10			0
16	Constant Speed	1	8	1	1. 0
17	Idle-Acceleration		10		1. 0
18	Constant Speed		10		1. 0
19	Idle		10		1. 0
20	Blank	10			0
21	Deceleration		10		1. 0
22	Constant Speed	3	7		0. 7
23	Idle-Acceleration		8	2	1. 2
24	Idle		10		1. 0

TABLE 6E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Average
1	Deceleration	5	5		0.5
2	Constant Speed	1	9		0.9
3	Constant Speed	3	7		0.7
4	Idle-Acceleration	1	7	2	1.1
5	Blank	10			0
6	Idle	4	6		0.6
7	Constant Speed		7	3	1.3
8	Idle	2	8		0.8
9	Deceleration	4	6		0.6
10	Blank	10			0
11	Constant Speed	3	7		0.7
12	Idle-Acceleration		8	2	1.2
13	Constant Speed	1	9		0.9
14	Deceleration	8	2		0.2
15	Blank	10			0
16	Constant Speed	3	6	1	0.8
17	Idle-Acceleration	1	7	2	1.1
18	Constant Speed	1	7	2	1.1
19	Idle	4	5	1	0.7
20	Blank	10			0
21	Deceleration	2	8		0.8
22	Constant Speed	3	6	1	0.8
23	Idle-Acceleration		6	4	1.4
24	Idle	2	8		0.8

TABLE 7. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 765
Date: July 16, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	I. Constant Speed	5.1	1.7	1.3	0.8	0.9
12	" "	5.6	1.7	1.5	1.1	0.9
17	" "	6.2	2.0	1.6	1.4	1.1
24	" "	5.5	1.8	1.4	1.3	0.9
		5.6	1.8	1.5	1.2	1.0
3	II. Constant Speed	4.0	1.3	1.1	0.9	0.3
8	" "	4.6	1.4	1.3	0.9	0.4
19	" "	5.5	1.9	1.7	1.1	0.8
22	" "	5.2	1.6	1.3	1.3	0.8
		4.8	1.6	1.4	1.1	0.6
5	III. Idle	4.7	1.5	1.1	0.9	0.6
10	"	3.9	1.1	0.9	0.8	0.3
13	"	4.8	1.7	1.3	1.0	0.6
20	"	4.8	1.4	1.1	1.1	0.7
		4.6	1.4	1.1	1.0	0.6
4	IV. Idle-Acceleration	5.5	1.8	1.5	1.0	0.9
6	" "	5.8	1.8	1.5	1.1	1.0
16	" "	6.1	2.0	1.7	1.2	1.0
23	" "	6.7	2.3	1.7	1.6	1.1
		6.0	2.0	1.6	1.2	1.0
2	V. Deceleration	5.9	1.9	1.6	1.0	1.2
9	"	6.9	2.5	1.6	1.4	1.3
14	"	6.2	2.0	1.7	1.3	1.0
21	"	6.7	2.3	1.6	1.5	1.3
		6.4	2.2	1.6	1.3	1.2

---

*Runs 7, 11, 15, and 18 were conducted without exhaust sample.

TABLE 7A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 765	Operating Conditions: See Table 2
Date: July 16, 1968	Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	3	4	5	6	7	Average
1	Constant Speed			2	5	3		5.1
2	Deceleration				4	3	3	5.9
3	Constant Speed			10				4.0
4	Idle-Acceleration				5	5		5.5
5	Idle			4	5	1		4.7
6	Idle-Acceleration				2	8		5.8
7	Blank	10						0
8	Constant Speed		1	5	1	3		4.6
9	Deceleration					1	9	6.9
10	Idle		1	9				3.9
11	Blank	10						0
12	Constant Speed				4	6		5.6
13	Idle			2	8			4.8
14	Deceleration				1	6	3	6.2
15	Blank	10						0
16	Idle-Acceleration				1	7	2	6.1
17	Constant Speed				2	4	4	6.2
18	Blank	10						0
19	Constant Speed				5	5		5.5
20	Idle			2	8			4.8
21	Deceleration					3	7	6.7
22	Constant Speed			1	6	3		5.2
23	Idle-Acceleration					3	7	6.7
24	Constant Speed		1		4	5		5.5

TABLE 7B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 765
Date: July 16, 1968

Operating Conditions: See Table 5
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Average
1	Constant Speed		3	7		6.7
2	Deceleration		2	7	1	1.9
3	Constant Speed		8	1	1	1.3
4	Idle-Acceleration		2	8		1.8
5	Idle		5	5		1.5
6	Idle-Acceleration		2	8		1.8
7	Blank	10				0
8	Constant Speed		6	4		1.4
9	Deceleration			5	5	2.5
10	Idle		9	1		1.1
11	Blank	10				0
12	Constant Speed		3	7		1.7
13	Idle		4	5	1	1.7
14	Deceleration		1	8	1	2.0
15	Blank	10				0
16	Idle-Acceleration		1	8	1	2.0
17	Constant Speed		1	8	1	2.0
18	Blank	10				0
19	Constant Speed		1	9		1.9
20	Idle		6	4		1.4
21	Deceleration			7	3	2.3
22	Constant Speed		4	6		1.6
23	Idle-Acceleration		1	5	4	2.3
24	Constant Speed		3	6	1	1.8

TABLE 7C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 765
Date: July 16, 1968

Operating Conditions: See Table 2
Fuel: EM-70-E (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		7	3	1.3
2	Deceleration		4	6	1.6
3	Constant Speed		9	1	1.1
4	Idle-Acceleration		5	5	1.5
5	Idle		9	1	1.1
6	Idle-Acceleration		5	5	1.5
7	Blank	10			0
8	Constant Speed		7	3	1.3
9	Deceleration		4	6	1.6
10	Idle	1	9		0.9
11	Blank	10			0
12	Constant Speed		5	5	1.5
13	Idle		7	3	1.3
14	Deceleration		3	7	1.7
15	Blank	10			0
16	Idle-Acceleration		3	7	1.7
17	Constant Speed		4	6	1.6
18	Blank	10			0
19	Constant Speed		3	7	1.7
20	Idle		9	1	1.1
21	Deceleration		4	6	1.6
22	Constant Speed		7	3	1.3
23	Idle-Acceleration		3	7	1.7
24	Constant Speed		6	4	1.4

TABLE 7D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 765
Date: July 16, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	2	8		0.8
2	Deceleration		10		1.0
3	Constant Speed	1	9		0.9
4	Idle-Acceleration	2	6	2	1.0
5	Idle	2	7	1	0.9
6	Idle-Acceleration		9	1	1.1
7	Blank	10			0
8	Constant Speed	1	9		0.9
9	Deceleration	1	4	5	1.4
10	Idle	2	8		0.8
11	Blank	10			0
12	Constant Speed		9	1	1.1
13	Idle		10		1.0
14	Deceleration		7	3	1.3
15	Blank	10			0
16	Idle-Acceleration	1	6	3	1.2
17	Constant Speed		6	4	1.4
18	Blank	10			0
19	Constant Speed	1	7	2	1.1
20	Idle		9	1	1.1
21	Deceleration		5	5	1.5
22	Constant Speed		7	3	1.3
23	Idle-Acceleration		4	6	1.6
24	Constant Speed		7	3	1.3

TABLE 7E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 765
Date: July 16, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	1	9		0.9
2	Deceleration	1	6	3	1.2
3	Constant Speed	7	3		0.3
4	Idle-Acceleration	1	9		0.9
5	Idle	4	6		0.6
6	Idle-Acceleration	1	8	1	1.0
7	Blank	10			0
8	Constant Speed	6	4		0.4
9	Deceleration		7	3	1.3
10	Idle	7	3		0.3
11	Blank	10			0
12	Constant Speed	1	9		0.9
13	Idle	4	6		0.6
14	Deceleration	1	8	1	1.0
15	Blank	10			0
16	Idle-Acceleration	1	8	1	1.0
17	Constant Speed	1	7	2	1.1
18	Blank	10			0
19	Constant Speed	2	8		0.8
20	Idle	3	7		0.7
21	Deceleration		7	3	1.3
22	Constant Speed	2	8		0.8
23	Idle-Acceleration	1	7	2	1.1
24	Constant Speed	2	7	1	0.9

TABLE 8. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 766
Date: July 17, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
8	I. Constant Speed	4.2	1.1	0.9	0.6	0.4
11	" "	5.6	1.9	1.4	1.1	0.9
20	" "	5.4	1.7	1.3	1.3	0.8
24	" "	5.3	1.7	1.2	1.1	0.7
		5.1	1.6	1.2	1.0	0.7
1	II. Constant Speed	4.7	1.3	1.1	0.9	0.6
5	" "	3.6	1.1	0.9	0.8	0.3
17	" "	5.4	1.6	1.4	1.2	0.8
21	" "	5.4	1.5	1.1	1.2	0.6
		4.8	1.4	1.1	1.0	0.6
3	III. Idle	4.1	1.1	0.9	0.9	0.4
6	"	4.2	0.9	0.9	0.8	0.2
14	"	4.7	1.4	1.1	1.0	0.7
16	"	4.4	1.2	1.1	1.0	0.6
		4.4	1.2	1.0	0.9	0.5
2	IV. Idle-Acceleration	4.9	1.6	1.3	0.8	0.5
9	" "	5.0	1.5	1.0	1.0	0.7
19	" "	6.0	2.0	1.5	1.3	0.8
22	" "	5.7	1.7	1.6	1.0	0.8
		5.4	1.7	1.4	1.0	0.7
4	V. Deceleration	3.7	1.1	1.1	0.7	0.2
10	"	4.1	1.1	0.9	0.7	0.4
13	"	4.3	1.1	1.0	0.8	0.6
23	"	4.1	1.2	1.1	0.8	0.5
		4.1	1.1	1.0	0.8	0.4

---

*Runs 7, 12, 15, and 18 were conducted without exhaust sample.

TABLE 8A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 766
Date: July 17, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	2	3	4	5	6	Average
1	Constant Speed				3	7		4.7
2	Idle-Acceleration				2	7	1	4.9
3	Idle			1	7	2		4.1
4	Deceleration		1	3	4	2		3.7
5	Constant Speed			6	2	2		3.6
6	Idle				8	2		4.2
7	Blank	10						0
8	Constant Speed				8	2		4.2
9	Idle-Acceleration				2	6	2	5.0
10	Deceleration			1	7	2		4.1
11	Constant Speed				1	2	7	5.6
12	Blank	10						0
13	Deceleration			1	6	2	1	4.3
14	Idle				4	5	1	4.7
15	Blank	10						0
16	Idle				6	4		4.4
17	Constant Speed				2	2	6	5.4
18	Blank	10						0
19	Idle-Acceleration						10	6.0
20	Constant Speed				1	4	5	5.4
21	Constant Speed					6	4	5.4
22	Idle-Acceleration				1	1	8	5.7
23	Deceleration			1	7	2		4.1
24	Constant Speed					7	3	5.3

TABLE 8B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 766
Date: July 17, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	Average
1	Constant Speed		7	3	1.3
2	Idle-Acceleration		4	6	1.6
3	Idle		9	1	1.1
4	Deceleration		9	1	1.1
5	Constant Speed		9	1	1.1
6	Idle	1	9		0.9
7	Blank	10			0
8	Constant Speed		9	1	1.1
9	Idle-Acceleration		5	5	1.5
10	Deceleration		9	1	1.1
11	Constant Speed		1	9	1.9
12	Blank	10			0
13	Deceleration		9	1	1.1
14	Idle		6	4	1.4
15	Blank	10			0
16	Idle		8	2	1.2
17	Constant Speed		4	6	1.6
18	Blank	10			0
19	Idle-Acceleration			10	2.0
20	Constant Speed		3	7	1.7
21	Constant Speed		5	5	1.5
22	Idle-Acceleration		3	7	1.7
23	Deceleration		8	2	1.2
24	Constant Speed		3	7	1.7

TABLE 8C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 766
Date: July 17, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		9	1	1.1
2	Idle-Acceleration		7	3	1.3
3	Idle	1	9		0.9
4	Deceleration		9	1	1.1
5	Constant Speed	1	9		0.9
6	Idle	1	9		0.9
7	Blank	10			0
8	Constant Speed	1	9		0.9
9	Idle-Acceleration		10		1.0
10	Deceleration	1	9		0.9
11	Constant Speed		6	4	1.4
12	Blank	10			0
13	Deceleration	1	8	1	1.0
14	Idle		9	1	1.1
15	Blank	10			0
16	Idle		9	1	1.1
17	Constant Speed		6	4	1.4
18	Blank	10			0
19	Idle-Acceleration		5	5	1.5
20	Constant Speed		7	3	1.3
21	Constant Speed		9	1	1.1
22	Idle-Acceleration		4	6	1.6
23	Deceleration		9	1	1.1
24	Constant Speed		8	2	1.2

TABLE 8D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 766
Date: July 17, 1966

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	1	9		0.9
2	Idle-Acceleration	2	8		0.8
3	Idle	1	9		0.9
4	Deceleration	3	7		0.7
5	Constant Speed	2	8		0.8
6	Idle	2	8		0.8
7	Blank	10			0
8	Constant Speed	4	6		0.6
9	Idle-Acceleration	1	8	1	1.0
10	Deceleration	3	7		0.7
11	Constant Speed	1	7	2	1.1
12	Blank	10			0
13	Deceleration	2	8		0.8
14	Idle		10		1.0
15	Blank	10			0
16	Idle		10		1.0
17	Constant Speed		8	2	1.2
18	Blank	10			0
19	Idle-Acceleration		7	3	1.3
20	Constant Speed	1	5	4	1.3
21	Constant Speed		8	2	1.2
22	Idle-Acceleration	2	6	2	1.0
23	Deceleration	2	8		0.8
24	Constant Speed		9	1	1.1

TABLE 8E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 766
Date: July 17, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	4	6		0.6
2	Idle-Acceleration	5	5		0.5
3	Idle	6	4		0.4
4	Deceleration	8	2		0.2
5	Constant Speed	7	3		0.3
6	Idle	8	2		0.2
7	Blank	10			0
8	Constant Speed	6	4		0.4
9	Idle-Acceleration	3	7		0.7
10	Deceleration	6	4		0.4
11	Constant Speed	1	9		0.9
12	Blank	10			0
13	Deceleration	4	6		0.6
14	Idle	3	7		0.7
15	Blank	10			0
16	Idle	4	6		0.6
17	Constant Speed	3	6	1	0.8
18	Blank	10			0
19	Idle-Acceleration	2	8		0.8
20	Constant Speed	3	6	1	0.8
21	Constant Speed	4	6		0.6
22	Idle-Acceleration	3	6	1	0.8
23	Deceleration	5	5		0.5
24	Constant Speed	3	7		0.7

TABLE 9. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

		Average Panel Responses				
Run No.*	Operating Condition	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	I. Constant Speed	4.3	1.3	1.1	0.9	0.3
8	" "	5.0	1.4	1.4	1.2	0.5
14	" "	5.3	1.8	1.2	1.2	1.0
22	" "	5.3	1.8	1.2	1.2	0.9
		5.0	1.6	1.2	1.1	0.7
1	II. Constant Speed	4.6	1.4	1.2	0.8	0.5
7	" "	4.4	1.3	1.2	0.7	0.5
10	" "	5.2	1.6	1.4	1.1	0.8
24	" "	5.1	1.5	1.2	0.9	0.8
		4.8	1.5	1.3	0.9	0.7
4	III. Idle	5.2	1.7	1.3	0.9	0.6
11	"	5.7	1.9	1.7	1.2	1.0
18	"	5.2	1.7	1.4	1.1	0.7
23	"	4.6	1.3	1.1	0.9	0.6
		5.2	1.7	1.4	1.0	0.7
6	IV. Idle-Acceleration	6.0	2.1	1.8	1.3	1.0
13	" "	6.5	2.1	1.9	1.4	1.4
17	" "	6.7	2.2	1.7	1.3	1.2
21	" "	6.0	1.9	1.6	0.9	1.1
		6.3	2.1	1.8	1.2	1.2
5	V. Deceleration	7.0	2.6	1.9	1.5	1.3
15	"	6.9	2.4	1.7	1.1	1.1
19	"	6.7	2.4	1.6	1.3	1.2
20	"	6.4	2.1	1.6	1.3	1.1
		6.8	2.4	1.7	1.3	1.2

---

*Runs 3, 9, 12, and 16 were conducted without exhaust sample.

TABLE 9A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses							
		0	3	4	5	6	7	8	Average
1	Constant Speed			4	6				4.6
2	Constant Speed			7	3				4.3
3	Blank	10							0
4	Idle				8	2			5.2
4	Deceleration						10		7.0
6	Idle-Acceleration					10			6.0
7	Constant Speed			6	4				4.4
8	Constant Speed			3	4	3			5.0
9	Blank	10							0
10	Constant Speed				8	2			5.2
11	Idle				3	7			5.7
12	Blank	10							0
13	Idle-Acceleration					5	5		6.5
14	Constant Speed			1	5	4			5.3
15	Deceleration					1	9		6.9
16	Blank	10							0
17	Idle-Acceleration				1	1	8		6.7
18	Idle			1	6	3			5.2
19	Deceleration					4	5	1	6.7
20	Deceleration					6	4		6.4
21	Idle-Acceleration				2	6	2		6.0
22	Constant Speed				7	3			5.3
23	Idle			5	4	1			4.6
24	Constant Speed		1	1	4	4			5.1

TABLE 9B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		6	4		1.4
2	Constant Speed		7	3		1.3
3	Blank	10				0
4	Idle		3	7		1.7
5	Deceleration			4	6	2.6
6	Idle-Acceleration			9	1	2.1
7	Constant Speed		7	3		1.3
8	Constant Speed		6	4		1.4
9	Blank	10				0
10	Constant Speed		4	6		1.6
11	Idle		2	7	1	1.9
12	Blank	10				0
13	Idle-Acceleration			9	1	2.1
14	Constant Speed		2	8		1.8
15	Deceleration			6	4	2.4
16	Blank	10				0
17	Idle-Acceleration		1	6	3	2.2
18	Idle		3	7		1.7
19	Deceleration			6	4	2.4
20	Deceleration		1	7	2	2.1
21	Idle-Acceleration		3	5	2	1.9
22	Constant Speed		5	4	1	1.8
23	Idle		7	3		1.3
24	Constant Speed		5	5		1.5

TABLE 9C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		8	2	1.2
2	Constant Speed		9	1	1.1
3	Blank	10			0
4	Idle		7	3	1.3
5	Deceleration		1	9	1.9
6	Idle-Acceleration		2	8	1.8
7	Constant Speed		8	2	1.2
8	Constant Speed		6	4	1.4
9	Blank	10			0
10	Constant Speed		6	4	1.4
11	Idle		3	7	1.7
12	Blank	10			0
13	Idle-Acceleration		1	9	1.9
14	Constant Speed	1	6	3	1.2
15	Deceleration		3	7	1.7
16	Blank	10			0
17	Idle-Acceleration		3	7	1.7
18	Idle		6	4	1.4
19	Deceleration		4	6	1.6
20	Deceleration		4	6	1.6
21	Idle-Acceleration		4	6	1.6
22	Constant Speed		8	2	1.2
23	Idle		9	1	1.1
24	Constant Speed		8	2	1.2

TABLE 9D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	2	8		0. 8
2	Constant Speed	1	9		0. 9
3	Blank	10			0
4	Idle	2	7	1	0. 9
5	Deceleration	1	3	6	1. 5
6	Idle-Acceleration	1	5	4	1. 3
7	Constant Speed	3	7		0. 7
8	Constant Speed		8	2	1. 2
9	Blank	10			0
10	Constant Speed		9	1	1. 1
11	Idle	1	6	3	1. 2
12	Blank	10			0
13	Idle-Acceleration		6	4	1. 4
14	Constant Speed		8	2	1. 2
15	Deceleration	1	7	2	1. 1
16	Blank	10			0
17	Idle-Acceleration		7	3	1. 3
18	Idle	1	7	2	1. 1
19	Deceleration		7	3	1. 3
20	Deceleration		7	3	1. 3
21	Idle-Acceleration	2	7	1	0. 9
22	Constant Speed		8	2	1. 2
23	Idle	1	9		0. 9
24	Constant Speed	2	7	1	0. 9

TABLE 9E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Constant Speed	5	5		0. 5
2	Constant Speed	7	3		0. 3
3	Blank	10			0
4	Idle	4	6		0. 6
5	Deceleration	1	5	4	1. 3
6	Idle-Acceleration	1	8	1	1. 0
7	Constant Speed	5	5		0. 5
8	Constant Speed	5	5		0. 5
9	Blank	10			0
10	Constant Speed	2	8		0. 8
11	Idle	1	8	1	1. 0
12	Blank	10			0
13	Idle-Acceleration	1	4	5	1. 4
14	Constant Speed	2	6	2	1. 0
15	Deceleration	1	7	2	1. 1
16	Blank	10			0
17	Idle-Acceleration		8	2	1. 2
18	Idle	3	7		0. 7
19	Deceleration		8	2	1. 2
20	Deceleration	1	7	2	1. 1
21	Idle-Acceleration		9	1	1. 1
22	Constant Speed	1	9		0. 9
23	Idle	4	6		0. 6
24	Constant Speed	3	6	1	0. 8

TABLE 10. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
6	I. Constant Speed	5.3	1.5	1.4	1.0	0.6
8	" "	5.2	1.6	1.3	0.7	0.8
12	" "	5.5	1.7	1.3	1.1	0.9
20	" "	5.4	1.7	1.4	1.0	0.9
		5.4	1.6	1.4	1.0	0.8
2	II. Constant Speed	3.8	1.2	1.1	0.8	0.3
17	" "	5.9	1.6	1.7	1.1	1.0
19	" "	5.7	1.6	1.5	1.2	0.9
23	" "	5.5	1.8	1.2	1.2	0.8
		5.2	1.6	1.4	1.1	0.8
5	III. Idle	5.0	1.4	1.1	0.8	0.8
13	"	5.1	1.5	1.1	1.0	0.7
18	"	6.2	1.9	1.5	1.6	1.0
22	"	5.7	1.6	1.5	0.9	0.9
		5.5	1.6	1.3	1.1	0.9
4	IV. Idle-Acceleration	5.8	1.8	1.6	1.1	1.1
10	" "	6.2	2.0	1.7	1.2	0.9
15	" "	6.9	2.3	1.9	1.2	1.5
24	" "	6.8	2.3	1.9	1.3	1.2
		6.4	2.1	1.8	1.2	1.2
1	V. Deceleration	4.0	1.4	1.0	0.8	0.2
9	"	5.4	1.6	1.3	1.1	0.8
16	"	6.0	1.9	1.6	1.0	1.0
21	"	5.4	1.5	1.3	0.9	0.9
		5.2	1.6	1.3	1.0	0.7

---

*Runs 3, 7, 11, and 14 were conducted without exhaust sample.

TABLE 10A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	3	4	5	6	7	Average
1	Deceleration		3	4	3			4.0
2	Constant Speed		4	4	2			3.8
3	Blank	10						0
4	Idle-Acceleration				2	8		5.8
5	Idle		1		7	2		5.0
6	Constant Speed			1	5	4		5.3
7	Blank	10						0
8	Constant Speed				8	2		5.2
9	Deceleration			2	2	6		5.4
10	Idle-Acceleration				1	6	3	6.2
11	Blank	10						0
12	Constant Speed			1	3	6		5.5
13	Idle			1	7	2		5.1
14	Blank	10						0
15	Idle-Acceleration					1	9	6.9
16	Deceleration				2	6	2	6.0
17	Constant Speed				1	9		5.9
18	Idle					8	2	6.2
19	Constant Speed				3	7		5.7
20	Constant Speed				6	4		5.4
21	Deceleration			1	4	5		5.4
22	Idle				3	7		5.7
23	Constant Speed			1	3	6		5.5
24	Idle-Acceleration				1		9	6.8

TABLE 10B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Deceleration		6	4		1.4
2	Constant Speed		8	2		1.2
3	Blank	10				0
4	Idle-Acceleration		2	8		1.8
5	Idle		6	4		1.4
6	Constant Speed		5	5		1.5
7	Blank	10				0
8	Constant Speed		4	6		1.6
9	Deceleration		4	6		1.6
10	Idle-Acceleration		1	8	1	2.0
11	Blank	10				0
12	Constant Speed		3	7		1.7
13	Idle		5	5		1.5
14	Blank	10				0
15	Idle-Acceleration			7	3	2.3
16	Deceleration		2	7	1	1.9
17	Constant Speed		4	6		1.6
18	Idle		2	7	1	1.9
19	Constant Speed		4	6		1.6
20	Constant Speed		3	7		1.7
21	Deceleration		5	5		1.5
22	Idle		4	6		1.6
23	Constant Speed		2	8		1.8
24	Idle-Acceleration		1	5	4	2.3

TABLE 10C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses			
		0	1	2	Average
1	Deceleration	2	6	2	1.0
2	Constant Speed		9	1	1.1
3	Blank	10			0
4	Idle-Acceleration		4	6	1.6
5	Idle	1	7	2	1.1
6	Constant Speed		6	4	1.4
7	Blank	10			0
8	Constant Speed		7	3	1.3
9	Deceleration		7	3	1.3
10	Idle-Acceleration		3	7	1.7
11	Blank	10			0
12	Constant Speed		7	3	1.3
13	Idle		9	1	1.1
14	Blank	10			0
15	Idle-Acceleration		1	9	1.9
16	Deceleration		4	6	1.6
17	Constant Speed		3	7	1.7
18	Idle		5	5	1.5
19	Constant Speed		5	5	1.5
20	Constant Speed		6	4	1.4
21	Deceleration		7	3	1.3
22	Idle		5	5	1.5
23	Constant Speed		8	2	1.2
24	Idle-Acceleration		1	9	1.9

TABLE 10D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Deceleration	2	8		0.8
2	Constant Speed	2	8		0.8
3	Blank	10			0
4	Idle-Acceleration		9	1	1.1
5	Idle	2	8		0.8
6	Constant Speed	1	8	1	1.0
7	Blank	10			0
8	Constant Speed	3	7		0.7
9	Deceleration	2	7	1	1.1
10	Idle-Acceleration		8	2	1.2
11	Blank	10			0
12	Constant Speed		9	1	1.1
13	Idle		10		1.0
14	Blank	10			0
15	Idle-Acceleration	1	6	3	1.2
16	Deceleration	1	8	1	1.0
17	Constant Speed	1	7	2	1.1
18	Idle		4	6	1.6
19	Constant Speed		8	2	1.2
20	Constant Speed	1	8	1	1.0
21	Deceleration	2	7	1	0.9
22	Idle	2	7	1	0.9
23	Constant Speed		8	2	1.2
24	Idle-Acceleration		7	3	1.3

TABLE 10E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Deceleration	8	2		0.2
2	Constant Speed	7	3		0.3
3	Blank	10			0
4	Idle-Acceleration		9	1	1.1
5	Idle	2	8		0.8
6	Constant Speed	4	6		0.6
7	Blank	10			0
8	Constant Speed	2	8		0.8
9	Deceleration	2	8		0.8
10	Idle-Acceleration	1	9		0.9
11	Blank	10			0
12	Constant Speed	1	9		0.9
13	Idle	3	7		0.7
14	Blank	10			0
15	Idle-Acceleration		5	5	1.5
16	Deceleration		10		1.0
17	Constant Speed	1	8	1	1.0
18	Idle		10		1.0
19	Constant Speed	1	9		0.9
20	Constant Speed	1	9		0.9
21	Deceleration	2	7	1	0.9
22	Idle	2	7	1	0.9
23	Constant Speed	2	8		0.8
24	Idle-Acceleration	1	6	3	1.2

TABLE 11. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.*	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
5	I. Constant Speed	5.4	1.5	1.4	0.9	0.5
8	" "	4.7	1.2	1.0	0.9	0.5
18	" "	5.3	1.5	1.3	0.9	1.2
20	" "	5.2	1.3	1.1	1.1	1.0
		5.2	1.4	1.2	1.0	0.8
1	II. Constant Speed	4.5	1.1	1.1	0.9	0.5
3	" "	3.5	1.1	1.1	0.8	0.5
10	" "	4.0	1.2	1.2	0.8	0.2
23	" "	4.9	1.3	1.1	0.9	0.7
		4.2	1.2	1.1	0.9	0.5
2	III. Idle	3.4	1.0	0.9	0.8	0.3
11	"	5.1	1.5	1.0	0.9	0.5
17	"	4.1	1.1	1.0	0.9	0.8
24	"	4.9	1.4	1.1	0.9	0.6
		4.4	1.3	1.0	0.9	0.6
6	IV. Idle-Acceleration	5.7	1.7	1.4	1.0	0.8
14	" "	5.4	1.6	1.3	1.0	0.8
16	" "	5.4	1.7	1.2	1.2	0.6
22	" "	6.0	1.8	1.5	1.3	1.0
		5.6	1.7	1.4	1.1	0.8
7	V. Deceleration	5.7	1.8	1.7	1.1	0.9
13	"	6.4	2.2	1.9	1.1	1.0
15	"	5.1	1.9	1.4	1.3	0.8
21	"	6.1	2.0	1.6	1.4	0.9
		5.8	2.0	1.7	1.2	0.9

---

*Runs 4, 9, 12, and 19 were conducted without exhaust sample.

TABLE 11A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses							
		0	2	3	4	5	6	7	Average
1	Constant Speed				5	5			4.5
2	Idle		1	4	5				3.4
3	Constant Speed			6	3	1			3.5
4	Blank	10							0
5	Constant Speed					6	4		5.4
6	Idle-Acceleration					3	7		5.7
7	Deceleration					4	5	1	5.7
8	Constant Speed				3	7			4.7
9	Blank	10							0
10	Constant Speed			2	6	2			4.0
11	Idle					9	1		5.1
12	Blank	10							0
13	Deceleration						6	4	6.4
14	Idle-Acceleration				1	4	5		5.4
15	Deceleration					1	9		5.1
16	Idle-Acceleration				1	4	5		5.4
17	Idle			1	7	2			4.1
18	Constant Speed				1	5	4		5.3
19	Blank	10							0
20	Constant Speed					8	2		5.2
21	Deceleration					1	7	2	6.1
22	Idle-Acceleration					2	6	2	6.0
23	Constant Speed				2	7	1		4.9
24	Idle				2	7	1		4.9

TABLE 11B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses 0	1	2	3	Average
1	Constant Speed		9	1		1.1
2	Idle		10			1.0
3	Constant Speed		9	1		1.1
4	Blank	10				0
5	Constant Speed		5	5		1.5
6	Idle-Acceleration		3	7		1.7
7	Deceleration		2	8		1.8
8	Constant Speed		8	2		1.2
9	Blank	10				0
10	Constant Speed		8	2		1.2
11	Idle		5	5		1.5
12	Blank	10				0
13	Deceleration			8	2	2.2
14	Idle-Acceleration		4	6		1.6
15	Deceleration		1	9		1.9
16	Idle-Acceleration		3	7		1.7
17	Idle		9	1		1.1
18	Constant Speed		5	5		1.5
19	Blank	10				0
20	Constant Speed		7	3		1.3
21	Deceleration		1	8	1	2.0
22	Idle-Acceleration		2	8		1.8
23	Constant Speed		7	3		1.3
24	Idle		6	4		1.4

TABLE 11C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		9	1	1.1
2	Idle	1	9		0.9
3	Constant Speed		9	1	1.1
4	Blank	10			0
5	Constant Speed		6	4	1.4
6	Idle-Acceleration		6	4	1.4
7	Deceleration		3	7	1.7
8	Constant Speed		10		1.0
9	Blank	10			0
10	Constant Speed		8	2	1.2
11	Idle	1	8	1	1.0
12	Blank	10			0
13	Deceleration		1	9	1.9
14	Idle-Acceleration		7	3	1.3
15	Deceleration		6	4	1.4
16	Idle-Acceleration		8	2	1.2
17	Idle		10		1.0
18	Constant Speed		7	3	1.3
19	Blank	10			0
20	Constant Speed		9	1	1.1
21	Deceleration		4	6	1.6
22	Idle-Acceleration		5	5	1.5
23	Constant Speed		9	1	1.1
24	Idle		9	1	1.1

TABLE 11D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses 0	1	2	Average
1	Constant Speed	1	9		0.9
2	Idle	2	8		0.8
3	Constant Speed	2	8		0.8
4	Blank	10			0
5	Constant Speed	2	7	1	0.9
6	Idle-Acceleration	1	8	1	1.0
7	Deceleration		9	1	1.1
8	Constant Speed	1	9		0.9
9	Blank	10			0
10	Constant Speed	2	8		0.8
11	Idle	1	9		0.9
12	Blank	10			0
13	Deceleration	1	7	2	1.1
14	Idle-Acceleration	1	8	1	1.0
15	Deceleration	1	5	4	1.3
16	Idle-Acceleration	1	6	3	1.2
17	Idle	2	7	1	0.9
18	Constant Speed	1	9		0.9
19	Blank	10			0
20	Constant Speed		9	1	1.1
21	Deceleration	1	4	5	1.4
22	Idle-Acceleration		7	3	1.3
23	Constant Speed	1	9		0.9
24	Idle	1	9		0.9

TABLE 11E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses			
		0	1	2	Average
1	Constant Speed	5	5		0.5
2	Idle	7	3		0.3
3	Constant Speed	5	5		0.5
4	Blank	10			0
5	Constant Speed	5	5		0.5
6	Idle-Acceleration	2	8		0.8
7	Deceleration	1	9		0.9
8	Constant Speed	5	5		0.5
9	Blank	10			0
10	Constant Speed	8	2		0.2
11	Idle	5	5		0.5
12	Blank	10			0
13	Deceleration		10		1.0
14	Idle-Acceleration	2	8		0.8
15	Deceleration	2	8		0.8
16	Idle-Acceleration	4	6		0.6
17	Idle	2	8		0.8
18	Constant Speed		8	2	1.2
19	Blank	10			0
20	Constant Speed		10		1.0
21	Deceleration	1	9		0.9
22	Idle-Acceleration	1	8	1	1.0
23	Constant Speed	3	7		0.7
24	Idle	4	6		0.6

TABLE 12. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 770
Date: July 23, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No. *	Operating Condition	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	I. Constant Speed	5.0	1.3	1.0	1.0	0.9
3	" "	4.4	1.3	1.0	1.0	0.7
10	" "	4.3	1.0	0.9	0.8	0.7
24	" "	5.2	1.5	1.3	1.0	0.7
		4.7	1.3	1.1	1.0	0.8
5	II. Constant Speed	3.8	1.1	1.0	0.9	0.3
9	" "	4.3	1.1	1.1	0.9	0.6
16	" "	5.6	1.9	1.3	1.1	0.8
21	" "	5.8	1.7	1.6	1.0	0.9
		4.9	1.5	1.3	1.0	0.7
6	III. Idle	4.8	1.1	1.0	1.0	0.8
10	"	4.3	1.0	0.9	0.8	0.7
17	"	4.4	1.1	1.1	0.9	0.5
22	"	5.1	1.6	1.1	1.0	0.8
		4.7	1.2	1.0	0.9	0.7
13	IV. Idle-Acceleration	6.1	2.0	1.6	1.2	1.1
15	" "	6.5	2.0	1.6	1.3	1.0
18	" "	6.0	1.8	1.5	1.4	1.0
20	" "	6.1	1.9	1.6	1.2	1.2
		6.2	1.9	1.6	1.3	1.1
2	V. Deceleration	4.9	1.4	1.1	1.1	0.6
7	"	5.8	1.9	1.2	1.3	0.9
14	"	5.8	1.9	1.5	1.1	0.9
23	"	5.8	1.6	1.4	1.2	0.9
		5.4	1.7	1.3	1.2	0.8

---

*Runs 4, 8, 12, and 19 were conducted without exhaust sample.

TABLE 12A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Standard)

Vehicle: Bus 770
Date: July 23, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"D" Diesel Composite Responses						
		0	3	4	5	6	7	Average
1	Constant Speed				10			5.0
2	Deceleration			3	5	2		4.9
3	Constant Speed		1	5	3	1		4.4
4	Blank	10						0
5	Constant Speed		3	6	1			3.8
6	Idle			3	6	1		4.8
7	Deceleration				2	8		5.8
8	Blank	10						0
9	Constant Speed		2	3	5			4.3
10	Idle			7	3			4.3
11	Constant Speed			2	7	1		4.9
12	Blank	10						0
13	Idle-Acceleration					9	1	6.1
14	Deceleration				3	6	1	5.8
15	Idle-Acceleration				1	3	6	6.5
16	Constant Speed			1	3	5	1	5.6
17	Idle			6	4			4.4
18	Idle-Acceleration				1	8	1	6.0
19	Blank	10						0
20	Idle-Acceleration					9	1	6.1
21	Constant Speed			1	2	5	2	5.8
22	Idle			1	7	2		5.1
23	Deceleration			1	2	5	2	5.8
24	Constant Speed			2	4	4		5.2

TABLE 12B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 770
Date: July 23, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"B" Burnt-Smoky Responses				
		0	1	2	3	Average
1	Constant Speed		7	3		1.3
2	Deceleration		6	4		1.4
3	Constant Speed		7	3		1.3
4	Blank	10				0
5	Constant Speed	1	7	2		1.1
6	Idle	1	7	2		1.1
7	Deceleration		1	9		1.9
8	Blank	10				0
9	Constant Speed	1	7	2		1.1
10	Idle		10			1.0
11	Constant Speed		6	4		1.4
12	Blank	10				0
13	Idle-Acceleration			10		2.0
14	Deceleration		2	7	1	1.9
15	Idle-Acceleration		1	8	1	2.0
16	Constant Speed		1	9		1.9
17	Idle		9	1		1.1
18	Idle-Acceleration		2	8		1.8
19	Blank	10				0
20	Idle-Acceleration		1	9		1.9
21	Constant Speed		3	7		1.7
22	Idle		4	6		1.6
23	Deceleration		4	6		1.6
24	Constant Speed		5	5		1.5

TABLE 12C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 770
Date: July 23, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"O" Oily Responses 0	1	2	Average
1	Constant Speed		10		1.0
2	Deceleration	1	7	2	1.1
3	Constant Speed	1	8	1	1.0
4	Blank	10			0
5	Constant Speed		10		1.0
6	Idle		10		1.0
7	Deceleration		8	2	1.2
8	Blank	10			0
9	Constant Speed		9	1	1.1
10	Idle	1	9		0.9
11	Constant Speed		9	1	1.1
12	Blank	10			0
13	Idle-Acceleration		4	6	1.6
14	Deceleration		5	5	1.5
15	Idle-Acceleration		4	6	1.6
16	Constant Speed		7	3	1.3
17	Idle		9	1	1.1
18	Idle-Acceleration		5	5	1.5
19	Blank	10			0
20	Idle-Acceleration		4	6	1.6
21	Constant Speed		4	6	1.6
22	Idle		9	1	1.1
23	Deceleration		6	4	1.4
24	Constant Speed		7	3	1.3

TABLE 12D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 770
Date: July 23, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"A" Aromatic Responses			
		0	1	2	Average
1	Constant Speed		10		1. 0
2	Deceleration		9	1	1. 1
3	Constant Speed	1	8	1	1. 0
4	Blank	10			0
5	Constant Speed	1	9		0. 9
6	Idle	1	8	1	1. 0
7	Deceleration		7	3	1. 3
8	Blank	10			0
9	Constant Speed	1	9		0. 9
10	Idle	2	8		0. 8
11	Constant Speed		10		1. 0
12	Blank	10			0
13	Idle-Acceleration	1	6	3	1. 2
14	Deceleration		9	1	1. 1
15	Idle-Acceleration		7	3	1. 3
16	Constant Speed	1	7	2	1. 1
17	Idle	1	9		0. 9
18	Idle-Acceleration		6	4	1. 4
19	Blank	10			0
20	Idle-Acceleration		8	2	1. 2
21	Constant Speed	1	8	1	1. 0
22	Idle		10		1. 0
23	Deceleration		8	2	1. 2
24	Constant Speed	1	8	1	1. 0

TABLE 12E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 770
Date: July 23, 1968

Operating Conditions: See Table 2
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Condition	"P" Pungent Responses 0	1	2	Average
1	Constant Speed	1	9		0.9
2	Deceleration	4	6		0.6
3	Constant Speed	3	7		0.7
4	Blank	10			0
5	Constant Speed	7	3		0.3
6	Idle	2	8		0.8
7	Deceleration	1	9		0.9
8	Blank	10			0
9	Constant Speed	4	6		0.6
10	Idle	3	7		0.7
11	Constant Speed		10		1.0
12	Blank	10			0
13	Idle-Acceleration		9	1	1.1
14	Deceleration	1	9		0.9
15	Idle-Acceleration	1	8	1	1.0
16	Constant Speed	2	8		0 8
17	Idle	5	5		0.5
18	Idle-Acceleration	1	8	1	1.0
19	Blank	10			0
20	Idle-Acceleration		8	2	1.2
21	Constant Speed	3	5	2	0.9
22	Idle	2	8		0.8
23	Deceleration	1	9		0.9
24	Constant Speed	3	7		0.7

TABLE 13. SMOKE EVALUATION CONDITIONS EMPLOYED DURING STUDY OF VEHICLE VARIABILITY

Vehicle Data:	GM Truck and Coach Model TDH-4519 city bus powered by two-cycle Detroit Diesel 6V-71 N series, two-valve engine. Muffler under coach. Air-conditioning rack compensator removed. For vehicles equipped with Jacobs retarders, the retarder is not operated.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter.
Inertia:	Full inertia simulation via SwRI system.

OPERATING CONDITIONS

Type Operation	Vehicle Speed, mph	Transmission Drive Range	Vehicle Load, hp	For Details Refer to:
A. Constant Speed	20	High	Open-rack	Table 8 of Appendix B
B. Constant Speed	25	High	Open-rack	Table 8 of Appendix B
C. Constant Speed	30	High	Open-rack	Table 8 of Appendix B
D. Constant Speed	35	High	Open-rack	Table 8 of Appendix B
E. Idle-Acceleration	0-40	--	40 hp at 30 mph	Table 9 of Appendix B

TABLE 14. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 761
Date: July 9, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	49	6	5	5.7
B. Constant Speed	25	61	4	4	4.0
C. Constant Speed	30	72	4	3	3.3
D. Constant Speed	35	79	3.5	2.5	2.8

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	4	3	3.7
During Acceleration	2	1	1.7
After Upshift	3	2	2.3

TABLE 15. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 762	Operating Conditions: See Table 13
Date: July 10, 1968	Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	51	7	6	6.3
B. Constant Speed	25	65	4	3.5	3.8
C. Constant Speed	30	76	3.5	3.5	3.5
D. Constant Speed	35	85	3.5	3	3.2

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	2	2	2.0
During Acceleration	3	3	3.0
After Upshift	4	4	4.0

TABLE 16. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 763
Date: July 12, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	48	6	5	5.7
B. Constant Speed	25	63	4	3	3.3
C. Constant Speed	30	73	4	3	3.3
D. Constant Speed	35	80	3	2	2.7

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	4	4	4.0
During Acceleration	2	2	2.0
After Upshift	4	3	3.7

TABLE 17. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 764
Date: July 15, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	48	6	5	5.3
B. Constant Speed	25	62	4	3	3.3
C. Constant Speed	30	72	3	3	3.0
D. Constant Speed	35	81	3	3	3.0

Transient Operation--Idle-Acceleration(40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	5	3	4.0
During Acceleration	4	3	3.3
After Upshift	4	3	3.7

TABLE 18. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 765
Date: July 16, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	48	9	9	9.0
B. Constant Speed	25	59	6	6	6.0
C. Constant Speed	30	70	5	4	4.7
D. Constant Speed	35	79	4	3	3.3

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	6	6	6.0
During Acceleration	4	3	3.7
After Upshift	5	4	4.7

TABLE 19. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 766
Date: July 17, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, %		
			Max	Min	Average
A. Constant Speed	20	55	3	3	3.0
B. Constant Speed	25	67	2	2	2.0
C. Constant Speed	30	76	2	2	2.0
D. Constant Speed	35	86	2	2	2.0

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, %		
	Max	Min	Average
Start of Engine	2	2	2.0
During Acceleration	1	1	1.0
After Upshift	2	1	1.7

TABLE 20. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 767
Date: July 18, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	50	4	4	4.0
B. Constant Speed	25	64	3	3	3.0
C. Constant Speed	30	75	2	2	2.0
D. Constant Speed	35	87	2	2	2.0

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	9	7	7.7
During Acceleration	2	2	2.0
After Upshift	2	2	2.0

TABLE 21. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 768
Date: July 19, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	52	6	5	5.7
B. Constant Speed	25	65	4	4	4.0
C. Constant Speed	30	75	3	3	3.0
D. Constant Speed	35	86	3	3	3.0

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	5	4	4.7
During Acceleration	2	2	2.0
After Upshift	4	3	3.7

TABLE 22. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 769
Date: July 22, 1968

Operating Conditions: See Table 13
Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, %		
			Max	Min	Average
A. Constant Speed	20	53	6	4	5.0
B. Constant Speed	25	65	5	3	3.7
C. Constant Speed	30	77	3	2	2.7
D. Constant Speed	35	86	2	2	2.0

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, %		
	Max	Min	Average
Start of Engine	4	2	3.0
During Acceleration	2	1	1.7
After Upshift	3	3	3.0

TABLE 23. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: Bus 770	Operating Conditions: See Table 13
Date: July 23, 1968	Fuel: EM-70-F (No. 1 Diesel)

Constant Speed Results (all open-rack, maximum output)

Type of Operation	Vehicle Speed, mph	Vehicle Load, hp	PHS Smokemeter Reading, % Max	Min	Average
A. Constant Speed	20	51	6	5	5.7
B. Constant Speed	25	64	4	3	3.3
C. Constant Speed	30	73	3	2	2.3
D. Constant Speed	35	83	3	2	2.3

Transient Operation--Idle-Acceleration (40 hp at 30 mph, preset and retained)

Portion of "E" Idle-Acceleration	PHS Smokemeter Reading, % Max	Min	Average
Start of Engine	9	7	8.0
During Acceleration	3	3	3.0
After Upshift	3	2	2.7

APPENDIX D

BASELINE EMISSIONS FROM A VARIETY OF DIESEL-POWERED TRUCKS

TABLE 1. DESCRIPTION OF DIESEL POWERED TRUCK

Date Tested: November 26, 1968

Engine Make: Cummins NH-250

No. Cyl/Cycle: 6/4

BHP at rpm: 234 at 2100

Displacement: 855 - 5.5 X 6.0

Turbo/Naturally Aspirated: Naturally Aspirated

Tractor Source: Ryder Truck Rental

Tractor Mileage: 121,032

Tractor Make: Ford

Serial No: X00 JUA 58770

Cabover/Conv: Cabover

Tractor Model/Year: X002/1967

Transmission Make: Fuller Division of Dana Corporation

Transmission Model: Road Ranger

Transmission Speeds: 10

Rear Axle Make: Rockwell Standard Corporation

No. of Drive/Dead Axles: 2/0

No. of Axle Speeds: 1

Tire Size: 10.00 X 20

GVW: 45,000 lb

Ratio: 4.11

TABLE 2. ODOR EVALUATION CONDITIONS EMPLOYED FOR BASELINE DATA

Vehicle Data:	Inter-city tandem drive truck-tractor powered by Cummins NH-250 naturally aspirated diesel engine via Fuller RT9-10 Road Ranger 10-speed transmission and Eaton single-speed rear axles. Muffler on stack at right rear corner of cab.
Sampling Data:	Constant sample flow at 700:1 dilution level.
Inertia:	32,000-lb vehicle weight per SwRI inertia simulation system (16,000-lb vehicle weight per each of two drive axles).

OPERATING CONDITIONS

Type Operation	Engine Speed, rpm	Vehicle Load, hp	Drive Gear	Vehicle Speed, mph (approx.)	For Details, Refer to:
I. Constant Speed	1500	150	7	23	Table 3
II. Constant Speed	1800	150	7	27	Table 3
III. Constant Speed	2100	150	7	32	Table 3
IV. Constant Speed-Idle	575	0	N	--	Table 4
V. Idle-Acceleration	575-2300	0	1	0-8	Table 5
VI. Acceleration	1600-2100	60 hp at 2200 rpm 8th gear	9	43-53	Table 6
VII. Constant Speed-Deceleration	2100-0	160 hp at 2100 rpm 9th gear	9	52-0	Table 7

TABLE 3. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Vehicle Speeds and Loads:	The following are to be run under 32,000-lb vehicle weight inertia simulation.

Vehicle Speed, mph	Drive Gear	Engine Speed, rpm	Vehicle Load, hp	Power Level
23	7	1500	140	near maximum rack
27	7	1800	150	near maximum rack
32	7	2100	160	near maximum rack

Procedure:

(1) Operate at given stable engine and vehicle speed and load.

(2) Turn "on" panel alert light and turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation 45 sec after light is turned "on" and maintain stable operation.

(4) Panel turns light "off" when evaluation is complete. The evaluation requires 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

TABLE 3. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE (Cont'd)

(5) When panel turns "off" light, turn dilution system to "man" control and decelerate.

(6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 min; with 3-min rest, 6 min.

TABLE 4. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Vehicle Speed and Load:	Engine idled at 575 rpm after 1 min of operation in 8th gear at 36 mph, 155 hp and 1900-rpm engine speed.
Procedure:	(1) Operate vehicle in 8th gear at 36 mph, engine at 1900 rpm and producing 155 hp at rear wheels for 1 min. (2) After 1 min of stable operation, closed-rack decelerate to 30 mph and shift to neutral and allow engine to idle. (3) Turn "on" panel alert light and turn dilution system to "auto" when vehicle is shifted to neutral and engine is permitted to idle at 575 rpm. (4) Ring bell for panel exposure 30 sec after beginning of engine idle and continue idle. (5) Panel turns light "off" when evaluation is complete. The evaluations require 50 to 70 sec to complete. Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period. (6) When panel turns "off" light, turn dilution system to "man" control.

TABLE 4. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE (Cont'd)

(7) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 min; with 3-min rest, 6 min.

TABLE 5. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 32, 000-lb vehicle weight via SwRI System.

Vehicle Speed and Load: Engine idle at 575 rpm followed by normal acceleration from 0 to 8 mph in 1st gear with 0 hp impressed in water brake dynamometer.

Procedure:

(1) Turn "on" panel alert light, start engine and idle and turn dilution system to "auto."

(2) After 1 min of idle, 575-rpm engine speed, accelerate in 1st gear. (Inertia simulation of 32, 000-lb vehicle weight; 16, 000 lb per each of two drive axles.) Power is applied gradually essentially as in normal truck operation.

(3) Ring bell as engine speed crosses 1500 rpm on chart recorder (approximately 3 sec after start of acceleration) for panel exposure.

(4) Continue to accelerate to maximum engine and vehicle speed in 1st gear (2300 rpm and 8 mph), hold for 15 sec, then shift to neutral and turn "off" engine. Turn "off" light.

(5) Repeat items (1) through (4) above after 2-min rest. The original and repeat idle-acceleration constitute one run.

TABLE 5. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE (Cont'd)

(6) Wait 3 min between runs for panel test and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 4-1/2 min; with 3-min rest, 7-1/2 min.

TABLE 6. ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	32, 000-lb vehicle weight via SwRI System.
Vehicle Speed and Load:	Full-rack acceleration from 43 to 53 mph in 9th gear with 60 hp initially preset in water brake dynamometer and retained.
Procedure:	(1) Operate in 8th gear at 220-rpm engine speed, 43 mph, and preset 60 hp into dynamometer (30 hp/axle). (2) Turn "on" panel alert light and turn dilution system to "auto" control. (3) After 30 sec of stable operation in 8th gear at 60 hp, upshift to 9th gear and full-rack accelerate to 53 mph, load retained in dynamometer. (4) Ring bell for panel exposure on reaching 2100 rpm. (5) Continue to accelerate in 9th gear to 53 mph, 2200-rpm engine speed, and hold for 15 sec. (6) Turn "off" light and turn dilution system to "man" and decelerate to a holding condition in 8th gear. (7) Repeat items (1) through (5) above after 2-min rest. The original and repeat constitute one run.

TABLE 6. ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE (Cont'd)

(8) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 5 min; with 3-min rest, 8 min.

TABLE 7. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	32, 000-lb vehicle weight via SwRI System.
Vehicle Speed and Load:	Operate in 9th gear at 2100-rpm engine speed, 52-mph vehicle speed, at open-rack, 160 hp, for 1 min followed by closed-rack deceleration with load retained in water brake dynamometer.
Procedure:	(1) Operate in 9th gear at 2100-rpm engine speed and 52-mph vehicle speed at open-rack, 160 hp. (2) Turn "on" panel alert light and turn dilution system to "auto" control. (3) Continue to operate at stable constant-speed conditions for 1 min and then closed-rack decelerate with load retained in water brake dynamometer. (4) Ring bell for panel exposure 5 sec after start of closed-rack deceleration. (5) Continue deceleration another 10 sec and then turn "off" light and turn dilution system to "man" control. (6) Wait 2 min and repeat items (1) through (6) above. The original and repeat constitute one run.

TABLE 7. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE (Cont'd)

(7) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6 min; with 3-min rest, 9 min.

TABLE 8. SMOKE EVALUATION CONDITIONS FOR CUMMINS NH-250

Vehicle Data:	Cab-over Intercity tandem drive truck-tractor powered by Cummins NH-250 naturally aspirated diesel engine via Fuller RT910 Road Ranger 10-speed transmission and Eaton single-speed rear axles. Muffler on stack at right rear corner of cab.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter mounted 5-1/2 inches above stack.
Inertia:	32, 000-lb vehicle weight per SwRI inertia simulation system (16, 000-lb vehicle weight per each of two drive axles).

OPERATING CONDITIONS

Type Operation	Engine Speed, rpm	Vehicle Load, hp	Drive Gear	Vehicle Speed, mph	For Details, Refer to:
A. Constant Speed	1500	Open-rack	7	26	Table 9
B. Constant Speed	1700	Open-rack	7	29	Table 9
C. Constant Speed	1900	Open-rack	7	32	Table 9
D. Constant Speed	2100	Open-rack	7	36	Table 9
E. Constant Speed	2200	Open-rack	7	38	Table 9
F. Idle-Acceleration	575-2300	Open-rack*	1-10		Table 10

---

*With 40 hp preset in water brake dynamometer at 30 mph and retained.

TABLE 9. CONSTANT SPEED SMOKE EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel Division, General Motors Corporation 6-71 N in-line diesel engine through a Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speeds and Loads:	Maximum vehicle smoke is to be measured at maximum power open-rack condition in 7th gear at 1500-, 1700-, 1900-, 2100-, and 2200-rpm engine speed. Rear axles locked. 32,000-lb vehicle inertia simulation.
Procedure:	(1) Zero potentiometric recorder and 100 percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and accelerate to 7th gear and operate at 1500 rpm open-rack. After measurement of smoke, release load to increase to 1700 rpm. After smoke measurement, release load and operate at 1900 rpm. Similarly measure smoke at 2100- and 2200-rpm engine speed. (3) Repeat items (1) and (2) two times. Note: Each smoke measurement should be preceded by 30 sec of stable operation.

TABLE 10. ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Cummins NH-250 diesel engine through a Fuller 10-speed Road Ranger transmission and 2-speed rear axles.

Measurement Method: U. S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 inches above stack.

Warm-up: A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.

Vehicle Speed and Load: Full-rack acceleration from 5th into 6th into 7th into 8th into 9th into 10th gear under 32, 000-lb inertia simulation and with 40 hp total (20 hp per axle) preset in the water brake dynamometer at 30 mph and retained.

Procedure:

(1) Zero potentiometric recorder and 100 percent adjust smokemeter with engine "off" using 2 cfm of purge air.

(2) Start engine and allow to idle. Note maximum smoke at start on recorder and continue idle for 1 min.

(3) Accelerate to 10th gear full-rack under normal type driving habit with 32, 000-lb inertia simulation and the preset load of 40 hp at 30 mph.

(4) Note the maximum smoke during each acceleration in 5th, 6th, 7th, 8th, 9th, and 10th gears.

(5) Repeat steps (1) through (4) above two times.

TABLE 11. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Engine: Cummins NH-250
Operating Conditions: See Table 2
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	23 mph at 1500 rpm	3.0	0.8	0.8	0.8	0.1
7	23 mph at 1500 rpm	2.8	0.7	0.7	0.7	0.5
12	23 mph at 1500 rpm	2.3	0.8	0.6	0.6	0.1
15	23 mph at 1500 rpm	2.2	1.0	0.5	0.5	0
		2.6	0.8	0.7	0.7	0.2
6	27 mph at 1800 rpm	2.4	0.6	0.6	0.8	0.2
9	27 mph at 1800 rpm	2.3	0.7	0.6	0.5	0.1
11	27 mph at 1800 rpm	2.0	0.7	0.7	0.6	0.2
16	27 mph at 1800 rpm	1.9	0.7	0.6	0.5	0
		2.2	0.7	0.6	0.6	0.1
3	32 mph at 2100 rpm	2.3	0.9	0.6	0.6	0.1
4	32 mph at 2100 rpm	2.2	0.7	0.8	0.6	0.1
10	32 mph at 2100 rpm	1.9	0.6	0.6	0.7	0.1
13	32 mph at 2100 rpm	2.3	0.7	0.7	0.7	0.2
		2.2	0.7	0.7	0.7	0.1
2	Idle	2.4	0.8	0.8	0.8	0.2
5	"	2.7	0.7	0.7	0.8	0.1
8	"	4.4	1.1	0.8	0.8	0.5
14	"	2.6	0.9	0.7	0.6	0.1
		3.0	0.9	0.8	0.8	0.2
17	Idle-Acceleration	2.4	1.0	0.8	0.4	0
20	" "	2.0	0.6	0.8	0.7	0.2
24	" "	3.1	1.0	0.7	0.4	0.2
28	" "	2.6	0.8	0.7	0.4	0.2
		2.5	0.9	0.8	0.5	0.2
18	Acceleration	2.0	0.8	0.5	0.6	0
21	"	2.5	0.9	0.7	0.5	0.1
25	"	2.6	1.0	0.7	0.4	0
27	"	2.2	0.9	0.7	0.5	0.1
		2.3	0.9	0.7	0.5	0.1
19	Deceleration	3.0	0.9	0.8	0.7	0.1
22	"	3.4	1.0	0.8	0.5	0.2
23	"	2.8	1.0	0.6	0.7	0.1
26	"	3.1	0.9	0.7	0.7	0
		3.1	1.0	0.7	0.7	0.1

TABLE 11A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Results)

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Engine: Cummins NH-250
Operating Conditions: See Table 2

Run No.	Operating Conditions	"D" Diesel Composite Responses 1	2	3	4	5	Average
1	23 mph at 1500 rpm		3	4	3		3.0
2	Idle		6	4			2.4
3	32 mph at 2100 rpm		7	3			2.3
4	32 mph at 2100 rpm	1	6	3			2.2
5	Idle		5	3	2		2.7
6	27 mph at 1800 rpm		6	4			2.4
7	23 mph at 1500 rpm		3	6	1		2.8
8	Idle				6	4	4.4
9	27 mph at 1800 rpm		8	1	1		2.3
10	32 mph at 2100 rpm	2	7	1			1.9
11	27 mph at 1800 rpm		8	1			2.0
12	23 mph at 1500 rpm		7	3			2.3
13	32 mph at 2100 rpm	1	6	2	1		2.3
14	Idle	1	4	3	2		2.6
15	23 mph at 1500 rpm	3	3	3	1		2.2
16	27 mph at 1800 rpm	2	7	1			1.9
17	Idle-Acceleration	1	5	3	1		2.4
18	Acceleration	2	6	2			2.0
19	Deceleration	1	2	3	4		3.0
20	Idle-Acceleration	1	8	1			2.0
21	Acceleration		5	5			2.5
22	Deceleration			6	4		3.4
23	Deceleration		4	4	2		2.8
24	Idle-Acceleration		1	7	2		3.1
25	Acceleration	1	4	2	3		2.6
26	Deceleration		2	5	3		3.1
27	Acceleration	2	5	2	1		2.2
28	Idle-Acceleration		5	4	1		2.6

TABLE 11B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standards)

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Operating Conditions: See Table 2

Run No.	Operating Conditions	"B" Burnt-Smoky Responses			
		0	1	2	Average
1	23 mph at 1500 rpm	2	8		0. 8
2	Idle	2	8		0. 8
3	32 mph at 2100 rpm	1	9		0. 9
4	32 mph at 2100 rpm	3	7		0. 7
5	Idle	3	7		0. 7
6	27 mph at 1800 rpm	4	6		0. 6
7	23 mph at 1500 rpm	3	7		0. 7
8	Idle		9	1	1. 1
9	27 mph at 1800 rpm	3	7		0. 7
10	32 mph at 2100 rpm	4	6		0. 6
11	27 mph at 1800 rpm	3	7		0. 7
12	23 mph at 1500 rpm	2	8		0. 8
13	32 mph at 2100 rpm	3	7		0. 7
14	Idle	1	9		0. 9
15	23 mph at 1500 rpm		10		1. 0
16	27 mph at 1800 rpm	3	7		0. 7
17	Idle-Acceleration		10		1. 0
18	Acceleration	2	8		0. 8
19	Deceleration	1	9		0. 9
20	Idle-Acceleration	4	6		0. 6
21	Acceleration	1	9		0. 9
22	Deceleration		10		1. 0
23	Deceleration		10		1. 0
24	Idle-Acceleration		10		1. 0
25	Acceleration		10		1. 0
26	Deceleration	1	9		0. 9
27	Acceleration	1	9		0. 9
28	Idle-Acceleration	2	8		0. 8

TABLE 11C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Operating Conditions: See Table 2

Run No.	Operating Conditions	"O" Oily Responses 0	1	Average
1	23 mph at 1500 rpm	2	8	0.8
2	Idle	2	8	0.8
3	32 mph at 2100 rpm	4	6	0.6
4	32 mph at 2100 rpm	2	8	0.8
5	Idle	3	7	0.7
6	27 mph at 1800 rpm	4	6	0.6
7	23 mph at 1500 rpm	3	7	0.7
8	Idle	2	8	0.8
9	27 mph at 1800 rpm	4	6	0.6
10	32 mph at 2100 rpm	4	6	0.6
11	27 mph at 1800 rpm	3	7	0.7
12	23 mph at 1500 rpm	4	6	0.6
13	32 mph at 2100 rpm	3	7	0.7
14	Idle	3	7	0.7
15	23 mph at 1500 rpm	5	5	0.5
16	27 mph at 1800 rpm	4	6	0.6
17	Idle-Acceleration	2	8	0.8
18	Acceleration	5	5	0.5
19	Deceleration	2	8	0.8
20	Idle-Acceleration	2	8	0.8
21	Acceleration	3	7	0.7
22	Deceleration	2	8	0.8
23	Deceleration	4	6	0.6
24	Idle-Acceleration	3	7	0.7
25	Acceleration	3	7	0.7
26	Deceleration	3	7	0.7
27	Acceleration	3	7	0.7
28	Idle-Acceleration	3	7	0.7

TABLE 11D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Operating Conditions: See Table 2

Run No.	Operating Conditions	"A" Aromatic Responses		
		0	1	Average
1	23 mph at 1500 rpm	2	8	0.8
2	Idle	2	8	0.8
3	32 mph at 2100 rpm	4	6	0.6
4	32 mph at 2100 rpm	4	6	0.6
5	Idle	2	8	0.8
6	27 mph at 1800 rpm	2	8	0.8
7	23 mph at 1500 rpm	3	7	0.7
8	Idle	2	8	0.8
9	27 mph at 1800 rpm	5	5	0.5
10	32 mph at 2100 rpm	3	7	0.7
11	27 mph at 1800 rpm	4	6	0.6
12	23 mph at 1500 rpm	4	6	0.6
13	32 mph at 2100 rpm	3	7	0.7
14	Idle	4	6	0.6
15	23 mph at 1500 rpm	5	5	0.5
16	27 mph at 1800 rpm	5	5	0.5
17	Idle-Acceleration	6	4	0.4
18	Acceleration	4	6	0.6
19	Deceleration	3	7	0.7
20	Idle-Acceleration	3	7	0.7
21	Acceleration	5	5	0.5
22	Deceleration	5	5	0.5
23	Deceleration	3	7	0.7
24	Idle-Acceleration	6	4	0.4
25	Acceleration	6	4	0.4
26	Deceleration	3	7	0.7
27	Acceleration	5	5	0.5
28	Idle-Acceleration	6	4	0.4

TABLE 11E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Operating Conditions: See Table 2

Run No.	Operating Conditions	"P" Pungent Responses 0	1	Average
1	23 mph at 1500 rpm	9	1	0.1
2	Idle	8	2	0.2
3	32 mph at 2100 rpm	9	1	0.1
4	32 mph at 2100 rpm	9	1	0.1
5	Idle	9	1	0.1
6	27 mph at 1800 rpm	8	2	0.2
7	23 mph at 1500 rpm	5	5	0.5
8	Idle	5	5	0.5
9	27 mph at 1800 rpm	9	1	0.1
10	32 mph at 2100 rpm	9	1	0.1
11	27 mph at 1800 rpm	8	2	0.2
12	23 mph at 1500 rpm	9	1	0.1
13	32 mph at 2100 rpm	8	2	0.2
14	Idle	9	1	0.1
15	23 mph at 1500 rpm	10		0
16	27 mph at 1800 rpm	10		0
17	Idle-Acceleration	10		0
18	Acceleration	10		0
19	Deceleration	9	1	0.1
20	Idle-Acceleration	8	2	0.2
21	Acceleration	9	1	0.1
22	Deceleration	8	2	0.2
23	Deceleration	9	1	0.1
24	Idle-Acceleration	8	2	0.2
25	Acceleration	10		0
26	Deceleration	10		0
27	Acceleration	9	1	0.1
28	Idle-Acceleration	8	2	0.2

TABLE 12. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: 1967 Ford Tractor
Date: November 26, 1968

Engine: Cummins NH-250
Fuel: EM-29-F (No. 2 Diesel)

Constant Speed (all at maximum power)

Operating Conditions*	Engine Speed, rpm	Vehicle Output, obs hp	Vehicle Speed, mph	Transmission Drive Range	PHS Smoke Reading, Percent Opacity		
					Max	Min	Average
A	1500	142	24	7	12	11	11
B	1700	158	26	7	11	11	11
C	1900	166	30	7	11	11	11
D	2100	174	32	7	13	13	13
E	2200	116	34	7	7	6	6

Acceleration (40 hp at 30 mph preset and retained)

Operating Conditions	Transmission Gear No.	PHS Smoke Reading, Percent Opacity		
		Max	Min	Average
F	5	9	7	8
	6	10	9	10
	7	11	8	9
	8	12	11	11
	9	13	12	13
	10	16	14	15

---

*See Tables 8 through 10 for details of operating procedures.

TABLE 13. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

Vehicle: 1967 Ford Tractor
Date: October 26, 1968

Operating Conditions: See Table 10

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde,* ppm	NO_x, ppm	NO, ppm	SO_2, ppm	Adjusting Factor
I	1	1750	6.4	70	0.93	20.59	2.03	1386.00	950	0.89	
23 mph,	7	1010	5.4	90	1.26	26.97	3.53	1397.05	960	1.05	
1500 rpm	12	1660	7.2	65	1.28	24.78	3.35	1313.05	1175	1.03	
	15	1900	6.5	75	1.25	22.60	4.11	1397.05	1150	0.89	
As-measured average		1580	6.4	75	1.18	23.74	3.26	1373.29	1059	0.92	
Adjusted average†		3670	14.82	174	2.74	55.1	7.56	3210	2460	2.4	2.32
II	6	940	7.5	75	1.26	23.50	1.37	1027.95	900	0.79	
27 mph,	9	780	6.0	65	1.13	21.48	2.13	1051.05	925	0.84	
1800 rpm	11	1400	7.4	75	1.15	23.32	3.09	1074.15	1100	1.09	
	16	825	6.0	75	1.13	19.89	1.37	1027.95	950	0.78	
As-measured average		986	6.7	73	1.17	22.05	1.99	1045.3	969	0.88	
Adjusted average†		2140	14.80	161	2.69	48.8	4.40	2310	2140	1.94	2.21
III	3	1160	7.5	80	1.10	22.38	2.71	843.15	900	0.85	
32 mph,	4	825	6.0	75	1.26	22.38	2.71	1143.45	800	0.62	
2100 rpm	10	1330	8.6	75	1.16	23.78	3.01	1120.35	1100	1.09	
	13	940	7.4	90	0.90	24.78	2.68	1143.45	1075	1.06	
As-measured average		1064	7.4	80	1.11	23.33	2.78	1062.6	969	.91	
Adjusted average†		2128	14.80	160	2.22	46.66	5.56	2125.2	1935	1.82	2.00
IV	2	75	0.6	100	0.78	29.54	2.03	127.05	220	0.61	
Idle	5	75	0.6	110	0.86	27.12	2.06	138.60	200	0.72	
	8	50	0.65	120	1.12	30.82	2.13	127.05	220	1.35	
	14	60	0.65	110	0.98	24.78	2.01	103.45	250	0.82	
As-measured average		65	0.63	110	0.94	28.07	2.06	124.04	223	0.88	
Adjusted average†		1570	14.98	2660	23.75	680	49.8	3000	5400	2.13	24.2

---

*Total as ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" average CO and CO_2 measurements.

TABLE 14. DESCRIPTION OF DIESEL POWERED TRUCK

Date Tested: January 14, 1969

Engine Make: General Motors--Detroit Diesel 6-71 N

No. Cyl/Cycle: 6/2

BHP at rpm: 238 at 2100

Displacement: 426

Turbo/Naturally Aspirated: Naturally Aspirated

Tractor Source: Hertz

Tractor Mileage: 253,514

Tractor Make: GMC

Serial No.: F21137L

Cabover/Conv: Cabover

Tractor Model/Year: DFW 17009/1964

Transmission Make: Fuller

Transmission Model: Road Ranger (R96)

Transmission Speeds: 10

Rear Axle Make: Rockwell

No. of Drive/Dead Axles: 2/0

No. of Axle Speeds: 2

Tire Size: 10.00 × 20

GVW: 45,000

Ratio: 4.11

TABLE 15. ODOR EVALUATION CONDITIONS EMPLOYED FOR BASELINE DATA

Vehicle Data:	Tandem drive truck-tractor powered by Detroit Diesel 6-71 naturally aspirated diesel engine via Fuller RT 9-10 Road Ranger 10-speed transmission and Eaton two-speed rear axles. Muffler under tractor.
Sampling Data:	Constant sample flow at 700:1 dilution level.
Inertia:	32,000-lb vehicle weight per SwRI inertia simulation system (16,000-lb vehicle weight per each of two drive axles).

OPERATING CONDITIONS

Type Operation	Engine Speed, rpm	Vehicle Load, hp	Drive Gear	Vehicle Speed, mph (approx)	For Details, Refer to:
I. Constant Speed	1500	140	7	23	Table 16
II. Constant Speed	1800	150	7	27	Table 16
III. Constant Speed	2100	140	7	32	Table 16
IV. Constant Speed-Idle	575	0	N	--	Table 17
V. Idle-Acceleration	575-2300	0	1	0-8	Table 18
VI. Acceleration	575-2100	60 hp at 2100 rpm 8th gear	9	43-53	Table 19
VII. Constant Speed-Deceleration	2100-0	140 hp at 2100 rpm 9th gear	9	52-0	Table 20

TABLE 16. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Detroit Diesel 6-71 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.

Vehicle Speeds and Loads: The following are to be run under 32,000-lb vehicle weight inertia simulation.

Vehicle Speed, mph	Drive Gear	Engine Speed, rpm	Vehicle Load, hp	Power Level
23	7	1500	140	near maximum rack
27	7	1800	150	near maximum rack
32	7	2100	140	near maximum rack

Procedure:

(1) Operate at given stable engine and vehicle speed and load.

(2) Turn "on" panel alert light and turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation 45 sec after light is turned "on" and maintain stable operation.

(4) Panel turns light "off" when evaluation is complete. The evaluation requires 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(5) When panel turns "off" light, turn dilution system to "man" control and decelerate.

(6) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end with light is turned back "on.")

Run Time: Approximately 3 min; with 3-min rest, 6 min.

TABLE 17. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Detroit Diesel 6V-71 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Vehicle Speed and Load: Engine idled at 575 rpm after 1 min of operation in 8th gear at 37 mph, 150 hp and 1900-rpm engine speed.

Procedure:

(1) Operate vehicle in 8th gear at 37 mph, engine at 1900 rpm and producing 150 hp at rear wheels for 1 min.

(2) After 1 min of stable operation, closed-rack decelerate to 30 mph and shift to neutral and allow engine to idle.

(3) Turn "on" panel alert light and turn dilution system to "auto" when vehicle is shifted to neutral and engine is permitted to idle at 575 rpm.

(4) Ring bell for panel exposure 30 sec after beginning of engine idle and continue idle.

(5) Panel turns light "off" when evaluation is complete. The evaluations require 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(6) When panel turns "off" light, turn dilution system to "man" control.

(7) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 min; with 3-min rest, 6 min.

TABLE 18. IDLE-ACCELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Detroit Diesel 6-71 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three turns should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.

Inertia Simulation: 32,000-lb vehicle weight via SwRI system.

Vehicle Speed and Load: Engine idle at 575 rpm followed by normal acceleration from 0 to 8 mph in 1st gear with 0 hp impressed in water brake dynamometer.

Procedure:

(1) Turn "on" panel alert light, start engine, and idle and turn dilution system to "auto."

(2) After 1 min of idle, 575-rpm engine speed, accelerate in 1st gear. (Inertia simulation of 32,000-lb vehicle weight; 16,000 lb per each of two drive axles.) Power is applied gradually essentially as in normal truck operation.

(3) Ring bell as engine speed crosses 1500 rpm on chart recorder (approximately 3 sec after start of acceleration) for panel exposure.

(4) Continue to accelerate to maximum engine and vehicle speed in 1st gear (2300 rpm and 8 mph), hold for 15 sec, then shift to neutral and turn "off" engine. Turn "off" light.

(5) Repeat items (1) through (4) above after 2-min rest. The original and repeat idle-acceleration constitute one run.

(6) Wait 3 min between runs for panel test and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 4-1/2 min; with 3-min rest, 7-1/2 min.

TABLE 19. ACCELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel 6-71 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.
Inertia Simulation:	32,000-lb vehicle weight via SwRI system.
Vehicle Speed and Load:	Full-rack acceleration from 40 to 53 mph in 9th gear with 60 hp initially impressed in water brake dynamometer and retained.

Procedure:

(1) Operate in 8th gear at 2100-rpm engine speed, 40 mph, and impress 60 hp into dynamometer.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) After 30 sec of stable operation in 8th gear at 60 hp, upshift to 9th gear and full-rack accelerate to 53 mph, load retained in dynamometer.

(4) Ring bell for panel exposure on reaching 2000 rpm.

(5) Continue to accelerate in 9th gear to 53 mph, 2100-rpm engine speed, and hold for 15 sec.

(6) Turn "off" light and turn dilution system to "man" and decelerate to a holding condition in 8th gear.

(7) Repeat items (1) through (5) above after 2-min rest. The original and repeat constitute one run.

(8) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 5 min; with 3-min rest, 8 min.

TABLE 20. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Detroit Diesel 6-71 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 32,000-lb vehicle weight via SwRI system.

Vehicle Speed and Load: Operate in 9th gear at 2100-rpm engine speed, 52-mph vehicle speed, at open-rack, 140 hp, for 1 min followed by closed-rack deceleration with load retained in water brake dynamometer.

Procedure:

(1) Operate in 9th gear at 2100-rpm engine speed and 52-mph vehicle speed at open-rack, 140 hp.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) Continue to operate at stable constant-speed conditions for 1 min and then closed-rack decelerate with load retained in water brake dynamometer.

(4) Ring bell for panel exposure 5 sec after start of closed-rack deceleration.

(5) Continue deceleration another 10 sec and then turn "off" light and turn dilution system to "man" control.

(6) Wait 2 min and repeat items (1) through (6) above. The original and repeat constitute one run.

(7) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6 min; with 3-min rest, 8 min.

TABLE 21. SMOKE EVALUATION CONDITIONS FOR DETROIT DIESEL 6-71 N ENGINE

Vehicle Data:	Cabover intercity tandem drive truck-tractor powered by 2-cycle Detroit Diesel Division, General Motors Corporation 6-71 N inline naturally aspirated diesel engine via Fuller RT910 Road Ranger 10-speed transmission and Eaton two-speed rear axles. Muffler under tractor.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter mounted 5-1/2 in. above stack.
Inertia:	32,000-lb vehicle weight per SwRI inertia simulation system (16,000-lb vehicle weight per each of two drive axles).

OPERATING CONDITIONS

Type Operation	Engine Speed, rpm	Vehicle Load, hp	Drive Gear	Vehicle Speed, mph	For Details, Refer to:
I. Constant Speed	1500	Open-rack	8	29	Table 22
II. Constant Speed	1700	Open-rack	8	33	Table 22
III. Constant Speed	1900	Open-rack	8	37	Table 22
IV. Constant Speed	2100	Open-rack	8	41	Table 22
V. Constant Speed	2200	Open-rack	8	43	Table 22
VI. Idle-Acceleration	575-2300	Open-rack *	1-10		Table 23

---

*With 40 hp preset in water brake dynamometer at 30 mph and retained.

TABLE 22. CONSTANT SPEED SMOKE EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel Division, General Motors Corporation 6-71 N inline diesel engine through a Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axles.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 in. above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speeds and Loads:	Maximum vehicle smoke is to be measured at maximum power open-rack condition in 7th gear at 1500-, 1700-, 1900-, 2100-, and 2200-rpm engine speed. Rear axles locked. 32,000-lb vehicle inertia simulation.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and accelerate to 7th gear and operate at 1500-rpm open-rack. After measurement of smoke, release load to increase to 1700 rpm. After smoke measurement, release load and operate at 1900 rpm. Similarly measure smoke at 2100- and 2200-rpm engine speed. (3) Repeat items (1) and (2) two times.

NOTE: Each smoke measurement should be preceded by 30 sec of stable operation.

TABLE 23. ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel 6-71 N diesel engine through a Fuller 10-speed Road Ranger transmission and Eaton two-speed rear axles.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 in. above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speed and Load:	Full-rack acceleration from 5th into 6th into 7th into 8th into 9th into 10th gear under 32,000-lb inertia simulation and with 40 hp total (20 hp per axle) preset in the water brake dynamometer at 30 mph and retained.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and allow to idle. Note maximum smoke at start on recorder and continue idle for 1 min. (3) Accelerate to 10th gear full-rack under normal type driving habit with 32,000-lb inertia simulation and the preset load of 40 hp at 30 mph. (4) Note the maximum smoke during each acceleration in 5th, 6th, 7th, 8th, 9th, and 10th gears. (5) Repeat steps (1) through (4) above two times.

TABLE 24. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 15
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	140 hp at 1500 rpm	3.8	1.0	0.9	0.9	0.2
8	140 hp at 1500 rpm	3.2	1.0	1.0	0.8	0.1
9	140 hp at 1500 rpm	3.7	1.0	0.9	0.9	0.1
15	140 hp at 1500 rpm	2.2	1.0	0.8	0.7	0.2
		3.1	1.0	0.9	0.8	0.2
2	150 hp at 1800 rpm	4.2	1.1	0.9	0.9	0.5
6	150 hp at 1800 rpm	4.1	1.0	1.0	1.0	0.8
11	150 hp at 1800 rpm	3.9	1.0	0.9	1.0	0.1
13	150 hp at 1800 rpm	2.9	0.9	0.9	0.5	0
		3.8	1.0	0.9	0.9	0.4
1	140 hp at 2100 rpm	4.4	1.1	1.0	0.9	0.3
7	140 hp at 2100 rpm	3.3	1.0	1.0	1.0	0.3
12	140 hp at 2100 rpm	3.0	1.0	0.9	0.8	0.2
14	140 hp at 2100 rpm	2.8	1.0	0.8	0.5	0.1
		3.4	1.0	0.9	0.8	0.2
3	Idle	3.1	1.0	0.8	1.0	0.1
5	"	3.0	1.0	0.9	0.9	0.1
10	"	3.7	1.0	0.9	1.0	0.3
16	"	3.6	1.0	0.8	0.8	0.3
		3.4	1.0	0.9	0.9	0.2
19	Idle-Acceleration	3.1	1.1	1.0	0.8	0.2
21	" "	3.9	1.1	1.0	0.9	0.3
23	" "	3.3	1.0	1.0	0.8	0.5
26	" "	2.9	0.9	1.0	0.8	0.3
		3.3	1.0	1.0	0.8	0.4
17	Acceleration	3.5	1.0	1.0	0.8	0.3
20	"	4.3	1.2	1.0	1.0	0.7
25	"	3.2	1.0	1.0	0.8	0.3
28	"	3.5	1.0	1.0	0.8	0.7
		3.6	1.1	1.0	0.9	0.5
18	Deceleration	3.1	1.0	0.9	0.9	0.2
22	"	3.8	1.0	1.0	0.9	0.5
24	"	2.9	0.9	1.0	0.9	0.2
27	"	2.7	0.9	1.0	0.9	0.2
		3.1	1.0	1.0	0.9	0.3

TABLE 24A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Results)

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 2

Run No.	Operating Conditions	"D" Diesel Composite Responses 1	2	3	4	5	Avg
1	140 hp at 2100 rpm			1	4	5	4.4
2	150 hp at 1800 rpm		1		5	4	4.2
3	Idle			9	1		3.1
4	140 hp at 1500 rpm			2	8		3.8
5	Idle		2	6	2		3.0
6	150 hp at 1800 rpm			1	7	2	4.1
7	140 hp at 2100 rpm			7	3		3.3
8	140 hp at 1500 rpm		2	4	4		3.2
9	140 hp at 1500 rpm		1	2	6	1	3.7
10	Idle			3	7		3.7
11	150 hp at 1800 rpm			1	9		3.9
12	140 hp at 2100 rpm		1	8	1		3.0
13	150 hp at 1800 rpm		2	7	1		2.9
14	140 hp at 2100 rpm		3	6	1		2.8
15	140 hp at 1500 rpm	1	6	3			2.2
16	Idle		1	2	7		3.6
17	Acceleration		1	3	6		3.5
18	Deceleration			9	1		3.1
19	Idle-Acceleration		1	7	2		3.1
20	Acceleration				7	3	4.3
21	Idle-Acceleration			1	9		3.9
22	Deceleration			2	8		3.8
23	Idle-Acceleration		1	5	4		3.3
24	Deceleration		2	7	1		2.9
25	Acceleration		1	7	1	1	3.2
26	Idle-Acceleration		3	5	2		2.9
27	Deceleration	1	2	6	1		2.7
28	Acceleration			5	5		3.5

TABLE 24B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 2

Run No.	Operating Conditions	"B" Burnt-Smoky Responses			
		0	1	2	Avg
1	140 hp at 2100 rpm		9	1	1.1
2	150 hp at 1800 rpm		9	1	1.1
3	Idle		10		1.0
4	140 hp at 1500 rpm		10		1.0
5	Idle		10		1.0
6	150 hp at 1800 rpm		10		1.0
7	140 hp at 2100 rpm		10		1.0
8	140 hp at 1500 rpm		10		1.0
9	140 hp at 1500 rpm		10		1.0
10	Idle		10		1.0
11	150 hp at 1800 rpm		10		1.0
12	140 hp at 2100 rpm		10		1.0
13	150 hp at 1800 rpm	1	9		0.9
14	140 hp at 2100 rpm		10		1.0
15	140 hp at 1500 rpm		10		1.0
16	Idle		10		1.0
17	Acceleration		10		1.0
18	Deceleration		10		1.0
19	Idle-Acceleration		9	1	1.1
20	Acceleration		8	2	1.2
21	Idle-Acceleration		9	1	1.1
22	Deceleration		10		1.0
23	Idle-Acceleration		10		1.0
24	Deceleration	1	9		0.9
25	Acceleration		10		1.0
26	Idle-Acceleration	1	9		0.9
27	Deceleration	1	9		0.9
28	Acceleration		10		1.0

TABLE 24C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 2

Run No.	Operating Conditions	"O" Oily Responses 0	1	2	Avg
1	140 hp at 2100 rpm	1	8	1	1.0
2	150 hp at 1800 rpm	1	9		0.9
3	Idle	2	8		0.8
4	140 hp at 1500 rpm	1	9		0.9
5	Idle	1	9		0.9
6	150 hp at 1800 rpm		10		1.0
7	140 hp at 2100 rpm		10		1.0
8	140 hp at 1500 rpm		10		1.0
9	140 hp at 1500 rpm	1	9		0.9
10	Idle	1	9		0.9
11	150 hp at 1800 rpm	1	9		0.9
12	140 hp at 2100 rpm	1	9		0.9
13	150 hp at 1800 rpm	1	9		0.9
14	140 hp at 2100 rpm	2	8		0.8
15	140 hp at 1500 rpm	2	8		0.8
16	Idle	2	8		0.8
17	Acceleration		10		1.0
18	Deceleration	1	9		0.9
19	Idle-Acceleration		10		1.0
20	Acceleration		10		1.0
21	Idle-Acceleration		10		1.0
22	Deceleration		10		1.0
23	Idle-Acceleration		10		1.0
24	Deceleration		10		1.0
25	Acceleration		10		1.0
26	Idle-Acceleration		10		1.0
27	Deceleration		10		1.0
28	Acceleration		10		1.0

TABLE 24D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 2

Run No.	Operating Conditions	"A" Aromatic Responses 0	1	Avg
1	140 hp at 2100 rpm	1	9	0.9
2	150 hp at 1800 rpm	1	9	0.9
3	Idle		10	1.0
4	140 hp at 1500 rpm	1	9	0.9
5	Idle	1	9	0.9
6	150 hp at 1800 rpm		10	1.0
7	140 hp at 2100 rpm		10	1.0
8	140 hp at 1500 rpm	2	8	0.8
9	140 hp at 1500 rpm	1	9	0.9
10	Idle		10	1.0
11	150 hp at 1800 rpm		10	1.0
12	140 hp at 2100 rpm	2	8	0.8
13	150 hp at 1800 rpm	5	5	0.5
14	140 hp at 2100 rpm	5	5	0.5
15	140 hp at 1500 rpm	3	7	0.7
16	Idle	2	8	0.8
17	Acceleration	2	8	0.8
18	Deceleration	1	9	0.9
19	Idle-Acceleration	2	8	0.8
20	Acceleration		10	1.0
21	Idle-Acceleration	1	9	0.9
22	Deceleration	1	9	0.9
23	Idle-Acceleration	.2	8	0.8
24	Deceleration	1	9	0.9
25	Acceleration	2	8	0.8
26	Idle-Acceleration	2	8	0.8
27	Deceleration	1	9	0.9
28	Acceleration	2	8	0.8

TABLE 24E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: 1964 GMC
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 2

Run No.	Operating Conditions	"P" Pungent Responses		
		0	1	Avg
1	140 hp at 2100 rpm	7	3	0.3
2	150 hp at 1800 rpm	5	5	0.5
3	Idle	9	1	0.1
4	140 hp at 1500 rpm	8	2	0.2
5	Idle	9	1	0.1
6	150 hp at 1800 rpm	2	8	0.8
7	140 hp at 2100 rpm	7	3	0.3
8	140 hp at 1500 rpm	9	1	0.1
9	140 hp at 1500 rpm	9	1	0.1
10	Idle	7	3	0.3
11	150 hp at 1800 rpm	9	1	0.1
12	140 hp at 2100 rpm	8	2	0.2
13	150 hp at 1800 rpm	10		0
14	140 hp at 2100 rpm	9	1	0.1
15	140 hp at 1500 rpm	8	2	0.2
16	Idle	7	3	0.3
17	Acceleration	7	3	0.3
18	Deceleration	8	2	0.2
19	Idle-Acceleration	8	2	0.2
20	Acceleration	3	7	0.7
21	Idle-Acceleration	7	3	0.3
22	Deceleration	5	5	0.5
23	Idle-Acceleration	5	5	0.5
24	Deceleration	8	2	0.2
25	Acceleration	7	3	0.3
26	Idle-Acceleration	7	3	0.3
27	Deceleration	8	2	0.2
28	Acceleration	3	7	0.7

TABLE 25. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: 1964 GMC	Engine: Detroit Diesel 6-71 N
Date: January 14, 1969	Operating Conditions: See Table 21

Constant Speed (all at maximum power)

Operating Conditions*	Engine Speed, rpm	Vehicle Output, obs hp	Vehicle Speed, mph	Transmission Drive Gear	PHS Smoke Reading, Percent Opacity		
					Max	Min	Average
A	1500	145	29	8	16	15	15.5
B	1700	145	33	8	14	14	14.0
C	1900	160	37	8	12	11	11.5
D	2100	180	41	8	4	3	3.5
E	2200	--	--	--	--	--	--

Acceleration (40 hp at 30 mph preset and retained)

Operating Conditions	Transmission Gear No.	PHS Smoke Reading, Percent Opacity		
		Max	Min	Average
F	5	13	10	12
	6	14	12	13
	7	16	16	16
	8	15	15	15
	9	15	13	14
	10	18	16	17

---

*See Tables 21 through 23 for details of operating procedures.

TABLE 26. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

Vehicle: GMC Tractor
Date: January 14, 1969

Engine: Detroit Diesel 6-71 N
Operating Conditions: See Table 15

Operating Conditions	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes*, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	SO_2, ppm	Adjusting Factor†
1500 rpm	1685	5.28	1170	3.25	19.19	9.02	1362.90	1650	0.65	
140 hp	1160	5.48	1005	2.13	15.73	7.70	1409.10	1650	0.70	
	910	5.48	1190	2.25	16.81	4.97	1351.35	1600	0.07	
	810	5.64	730	2.27	15.04	5.71	1039.50	1650	0.70	
"As-measured" average	1141	5.47	1024	2.48	16.69	6.85	1290.71	1638	0.53	
Adjusted average	3069	14.71	2755	6.67	44.90	18.43	3472.01	4410	1.43	2.69
1800 rpm	1015	6.07	730	4.80	35.26	15.07	1247.40	1560	0.14	
150 hp	735	5.20	750	3.79	16.45	6.25	1362.90	1560	1.05	
	1100	5.92	680	3.28	16.81	5.68	1258.95	1600	0.08	
	1190	5.92	660	3.41	17.86	6.43	1178.10	1650	0.10	
"As-measured" average	1010	5.78	705	3.82	21.59	8.36	1261.84	1593	0.34	
Adjusted average	2576	14.74	1800	9.74	55.05	21.32	3217.69	4060	0.87	2.55
2100 rpm	400	4.92	470	1.15	11.64	4.07	1143.45	1470	0.50	
140 hp	375	4.79	470	2.67	17.75	6.39	1374.45	1440	1.11	
	440	5.35	470	2.40	16.56	7.67	1282.05	1520	0.07	
	350	5.20	450	2.02	16.81	4.97	1201.20	1520	0.10	
"As-measured" average	391	5.07	465	2.06	15.69	5.78	1250.29	1488	0.45	
Adjusted average	1150	14.91	1370	6.06	46.13	16.99	3675.85	4370	1.32	2.94
Idle	185	0.62	380	2.90	23.76	8.33	207.90	330	0.35	
	145	0.59	380	2.75	18.28	7.63	207.90	220	0.08	
	135	0.65	355	2.84	17.58	7.70	231.00	260	0.13	
	160	0.70	425	2.47	18.90	7.90	184.80	280	0.15	
"As-measured" average	156	0.64	385	2.74	19.63	7.89	207.90	273	0.18	
Adjusted Average	3572	14.66	8810	62.75	449.53	108.68	4760.91	6250	4.12	22.9

---

*As ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" CO and CO_2 measurements.

TABLE 27. DESCRIPTION OF DIESEL POWERED TRUCK

Date Tested: January 31, 1969
Engine Make: Mack - ENDT 673C
No. Cyl/Cycle: 6/4
BHP at rpm: 250 at 2100
Displacement: 672 cu in.
Turbo/Naturally Aspirated: Turbocharged

Tractor Source: Riley Mack Distributorship
Tractor Mileage: 503,332
Tractor Make: Mack
Cabover/Conv: Cabover
Tractor Model/Year: F Series/1961
Transmission Make: Mack
Transmission Model: Triplex
Transmission Speeds: 15

Rear Axle Make: Mack
No. of Drive/Dead Axles: 1/0
No. of Axle Speeds: 3
Tire Size: 10.00 X 22
GVW: 23,700

TABLE 28. ODOR EVALUATION CONDITIONS EMPLOYED FOR BASELINE DATA

Vehicle Data:	Intercity single-drive axle truck-tractor powered by a Mack ENDT 673C turbocharged diesel engine through Mack Triplex 15-speed transmission and Mack single-speed rear axle.
Sampling Data:	Constant sample flow at 700:1 dilution level.
Inertia:	25,000-lb vehicle weight per SwRI inertia simulation system.

OPERATING CONDITIONS

Type Operation	Engine Speed, rpm	Vehicle Load, hp	Drive Gear	Vehicle Speed, mph (approx)	For Details, Refer to:
I. Constant Speed	1500	140	12	35	Table 29
II. Constant Speed	1800	140	12	41	Table 29
III. Constant Speed	2100	140	12	48	Table 29
IV. Constant Speed-Idle	575	0	N	--	Table 30
V. Idle-Acceleration	575-2300	0	1	0-8	Table 31
VI. Acceleration	575-2200	60 hp at 2200 rpm 12th gear	9	50-56	Table 32
VII. Constant Speed-Deceleration	2100-0	160 hp at 2100 rpm 13th gear	9	56-0	Table 33

TABLE 29. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Single-drive axle truck-tractor powered by a Mack ENDT 673 turbocharged diesel engine through Mack Triplex 15-speed transmission and single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.

Vehicle Speeds and Loads: The following are to be run under 25,000-lb vehicle weight inertia simulation.

Vehicle Speed, mph	Drive Gear	Engine Speed, rpm	Vehicle Load, hp	Power Level
35	12	1500	140	near maximum rack
41	12	1800	140	near maximum rack
48	12	2100	140	near maximum rack

Procedure:

(1) Operate at given stable engine and vehicle speed and load.

(2) Turn "on" panel alert light and turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation 45 sec after light is turned "on" and maintain stable operation.

(4) Panel turns light "off" when evaluation is complete. The evaluation requires 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(5) When panel turns "off" light, turn dilution system to "man" control and decelerate.

(6) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 min, with 3-min rest, 6 min.

TABLE 30. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Single-drive axle truck-tractor powered by a Mack ENDT 673 turbocharged diesel engine through Mack Triplex 15-speed transmission and single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.

Vehicle Speed and Load: Engine idled at 575 rpm after 1 min of operation in 12th gear at 43 mph, 120 hp, and 1900-rpm engine speed.

Procedure:

(1) Operate vehicle in 12th gear at 43 mph, engine at 1900 rpm, and producing 120 hp at rear wheels for 1 min.

(2) After 1 min of stable operation, closed-rack decelerate to 30 mph and shift to neutral and allow engine to idle.

(3) Turn "on" panel alert light and turn dilution system to "auto" when vehicle is shifted to neutral and engine is permitted to idle at 575 rpm.

(4) Ring bell for panel exposure 30 sec after beginning of engine idle and continue idle.

(5) Panel turns light "off" when evaluation is complete. The evaluations require 50 to 70 sec to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-sec period.

(6) When panel turns "off" light, turn dilution system to "man" control.

(7) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end with light is turned back "on.")

Run Time: Approximately 3 min, with 3-min rest, 6 min.

TABLE 31. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability:	Single drive axle truck-tractor powered by a Mack ENDT 673 turbocharged diesel engine through Mack Triplex 15-speed transmission and single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.
Inertia Simulation:	25,000-lb vehicle weight via SwRI system.
Vehicle Speed and Load:	Engine idle at 575 rpm followed by normal acceleration from 0 to 8 mph in 1st gear with 0 hp impressed in water brake dynamometer.
Procedure:	(1) Turn "on" panel alert light, start engine and idle and turn dilution system to "auto." (2) After 1 min of idle, 575-rpm engine speed, accelerate in 1st gear. (Inertia simulation of 25,000-lb vehicle weight) Power is applied gradually essentially as in normal truck operation. (3) Ring bell as engine speed crosses 1500 rpm on chart recorder (approximately 3 sec after start of acceleration) for panel exposure. (4) Continue to accelerate to maximum engine and vehicle speed in 1st gear (2300 rpm and 8 mph), hold for 15 sec, then shift to neutral and turn "off" engine. Turn "off" light. (5) Repeat items (1) through (4) above after 2-min rest. The original and repeat idle-acceleration constitute one run. (6) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time:	Approximately 4-1/2 min; with 3-min rest, 7-1/2 min.

TABLE 32. ACCELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Single-drive axle truck-tractor powered by a Mack ENDT 673 turbocharged diesel engine through Mack Triplex 15-speed transmission and single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 25,000-lb vehicle weight via SwRI system.

Vehicle Speed and Load: Full-rack acceleration from 50 to 56 mph in 13th gear with 60 hp initially impressed in water brake dynamometer and retained.

Procedure:

(1) Operate in 12th gear at 2200-rpm engine speed, 50 mph, and preset 60 hp into dynamometer.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) After 30 sec of stable operation in 12th gear at 60 hp, upshift to 13th gear and full-rack accelerate to 56 mph, load retained in dynamometer.

(4) Ring bell for panel exposure on reaching 2100 rpm.

(5) Continue to accelerate in 13th gear to 56 mph, 2200-rpm engine speed, and hold for 5 sec.

(6) Turn "off" light and turn dilution system to "man" and decelerate to a holding condition in 12th gear.

(7) Repeat items (1) through (5) above after 2-min rest. The original and repeat constitute one run.

(8) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 5 min; with 3-min rest, 8 min.

TABLE 33. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Single-drive axle truck-tractor powered by a Mack ENDT 673 diesel engine through Mack Triplex 15-speed transmission and single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and driveline systems have reached operating temperature.
Inertia Simulation:	25,000-lb vehicle weight via SwRI system.
Vehicle Speed and Load:	Operate in 13th gear at 2100-rpm engine speed, 56-mph vehicle speed, at near open-rack, 160 hp, for 1 min followed by closed-rack deceleration with load retained in water brake dynamometer.
Procedure:	(1) Operate in 13th gear at 2100-rpm engine speed and 56-mph vehicle speed at near open-rack, 160 hp. (2) Turn "on" panel alert light and turn dilution system to "auto" control. (3) Continue to operate at stable constant-speed conditions for 1 min and then closed-rack decelerate with load retained in water break dynamometer. (4) Ring bell for panel exposure 5 sec after start of closed-rack deceleration. (5) Continue deceleration another 10 sec and then turn "off" light and turn dilution system to "man" control. (6) Wait 2 min and repeat items (1) through (6) above. The original and repeat constitute one run. (7) Wait 3 min between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6 min; with 3-min rest, 9 min.

TABLE 34. SMOKE EVALUATION CONDITIONS FOR MACK TRUCK-TRACTOR

Vehicle Data:	Cabover Intercity single-drive truck-tractor powered by Mack ENDT 673 turbocharged diesel engine via Mack Triplex 15-speed transmission and single-speed rear axle.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter mounted 5-1/2 in. above stack.
Inertia:	25,000-lb vehicle weight per SwRI inertia simulation system.

OPERATING CONDITIONS

Type Operation	Engine Speed, rpm	Vehicle Load, hp	Drive Gear	Vehicle Speed, mph	For Details, Refer to:
I. Constant Speed	1100	Open-rack	14	37	Table 35
II. Constant Speed	1300	Open-rack	14	42	Table 35
III. Constant Speed	1500	Open-rack	14	48	Table 35
IV. Constant Speed	1700	Open-rack	14	53	Table 35
V. Constant Speed	1900	Open-rack	14	59	Table 35
VI. Constant Speed	2100	Open-rack	14	66	Table 35
VII. Constant Speed	2200	Open-rack	14	70	Table 35
VIII. Idle-Acceleration	575-2300	Open-rack *	8-13		Table 36

---

*With 40 hp preset in water brake dynamometer at 30 mph and retained.

TABLE 35. CONSTANT SPEED SMOKE EVALUATION PROCEDURE

Applicability:	Single-drive axle truck-tractor powered by a Mack ENDT 673 diesel engine through a Mack Triplex 15-speed transmission and single-speed rear axle.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speeds and Loads:	Maximum vehicle smoke is to be measured at maximum power open-rack condition in 14th gear at 1100-, 1300-, 1500-, 1700-, 1900-, 2100-, and 2200-rpm engine speed.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and accelerate to 14th gear and operate at 1100-rpm open rack. After measurement of smoke, release load to increase to 1300 rpm. After smoke measurement, release load and operate at 1500 rpm. Similarly measure smoke at 1700-, 1900-, 2100-, and 2200-rpm engine speed. (3) Repeat items (1) and (2) two times.

NOTE: Each smoke measurement should be preceded by 30 sec of stable operation.

TABLE 36. ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	Single-drive axle truck-tractor powered by a Mack ENDT 673 diesel engine through a Mack Triplex 15-speed transmission and single-speed rear axle.
Measurement Method:	U. S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 in. above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speed and Load:	Full-rack acceleration from 8th into 9th into 10th into 11th into 12th into 13th gear under 25,000-lb inertia simulation and with 40 hp total preset in the water brake dynamometer at 30 mph and retained.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and allow to idle. Note maximum smoke at start on recorder and continue idle for 1 min. (3) Accelerate to 13th gear full rack under normal type driving habit with 25,000-lb inertia simulation and the preset load of 40 hp at 30 mph. (4) Note the maximum smoke during each acceleration in 8th, 9th, 10th, 11th, 12th, and 13th gears. (5) Repeat steps (1) through (4) above two times.

TABLE 37. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT 673C
Operating Conditions: See Table 27
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	140 hp at 1500 rpm	2.6	0.5	0.9	0.9	0.1
8	140 hp at 1500 rpm	3.3	1.0	1.0	0.8	0.3
9	140 hp at 1500 rpm	3.4	0.9	0.9	0.9	0.5
15	140 hp at 1500 rpm	2.0	0.4	0.9	0.7	0.9
		2.8	0.7	0.9	0.8	0.5
2	140 hp at 1800 rpm	3.0	0.6	1.0	0.9	0.1
6	140 hp at 1800 rpm	2.5	0.8	1.0	0.7	0.3
11	140 hp at 1800 rpm	3.5	0.9	1.0	0.9	0.3
13	140 hp at 1800 rpm	2.9	0.7	0.9	0.9	0.9
		3.0	0.8	1.0	0.9	0.4
1	140 hp at 2100 rpm	2.6	0.6	1.0	0.7	0
7	140 hp at 2100 rpm	3.6	1.1	1.0	0.8	0.6
12	140 hp at 2100 rpm	3.1	0.8	0.9	0.9	0.9
14	140 hp at 2100 rpm	3.3	0.8	0.8	1.0	0.8
		3.2	0.8	0.9	0.9	0.6
3	Idle	2.7	0.7	0.9	0.9	0.1
5	"	2.8	0.9	0.9	0.8	0.2
10	"	3.1	1.0	0.9	0.8	0.1
16	"	3.2	0.8	0.9	0.9	0.8
		3.0	0.9	0.9	0.9	0.3
19	Idle-Acceleration	3.2	1.0	0.6	0.9	0.4
21	" "	2.4	0.7	0.9	0.7	0.3
23	" "	3.2	0.8	1.0	0.9	0.4
26	" "	2.8	0.6	0.9	0.7	0.3
		2.9	0.8	0.9	0.8	0.4
17	Acceleration	2.5	0.7	0.8	0.7	0
20	"	2.8	0.9	0.8	0.8	0.4
25	"	2.8	0.6	1.0	0.6	0.3
28	"	1.9	0.6	1.0	0.4	0.1
		2.5	0.7	0.9	0.6	0.2
18	Deceleration	2.6	0.8	0.9	0.8	0.1
22	"	3.3	0.8	0.9	0.9	0.2
24	"	3.6	0.9	1.0	0.9	0.3
27	"	2.2	0.8	1.0	0.5	0.3
		2.9	0.8	1.0	0.8	0.2

TABLE 37A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Results)

Vehicle: 1961 Mack	Engine: Mack ENDT-673C
Date: January 31, 1969	Operating Conditions: See Tables 27 through 32

Run No.	Operating Conditions	"D" Diesel Composite Responses						
		1	2	3	4	4-1/2	5	Avg
1	140 hp at 2100 rpm		5	4	1			2.6
2	140 hp at 1800 rpm			10				3.0
3	Idle		3	7				2.7
4	140 hp at 1500 rpm		4	6				2.6
5	Idle		3	6	1			2.8
6	140 hp at 1800 rpm	1	4	4	1			2.5
7	140 hp at 2100 rpm			4	6			3.6
8	140 hp at 1500 rpm			7	3			3.3
9	140 hp at 1500 rpm		1	5	3		1	3.4
10	Idle		3	3	4			3.1
11	140 hp at 1800 rpm	1		3	3	2	1	3.5
12	140 hp at 2100 rpm		2	5	3			3.1
13	140 hp at 1800 rpm		3	5	2			2.9
14	140 hp at 2100 rpm		1	5	4			3.3
15	140 hp at 1500 rpm	2	6	2				2.0
16	Idle		2	4	4			3.2
17	Acceleration		5	5				2.5
18	Deceleration	1	3	5	1			2.6
19	Idle-Acceleration		1	6	3			3.2
20	Acceleration		4	5	1			2.8
21	Idle-Acceleration	1	6	1	2			2.4
22	Deceleration		2	3	5			3.3
23	Idle-Acceleration		1	6	3			3.2
24	Deceleration			4	6			3.6
25	Acceleration		5	2	3			2.8
26	Idle-Acceleration		5	2	3			2.8
27	Deceleration	2	5	2	1			2.2
28	Acceleration	2	7	1				1.9

TABLE 37B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt Smoke Standard)

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT-673C
Operating Conditions: See Tables 27 through 32

Run No.	Operating Conditions	"B" Burnt Smoky Responses 0	1	2	Avg
1	140 hp at 2100 rpm	4	6		0.6
2	140 hp at 1800 rpm	4	6		0.6
3	Idle	3	7		0.7
4	140 hp at 1500 rpm	5	5		0.5
5	Idle	1	9		0.9
6	140 hp at 1800 rpm	2	8		0.8
7	140 hp at 2100 rpm		9	1	1.1
8	140 hp at 1500 rpm	1	8	1	1.0
9	140 hp at 1500 rpm	1	9		0.9
10	Idle		10		1.0
11	140 hp at 1800 rpm	1	9		0.9
12	140 hp at 2100 rpm	2	8		0.8
13	140 hp at 1800 rpm	3	7		0.7
14	140 hp at 2100 rpm	2	8		0.8
15	140 hp at 1500 rpm	6	4		0.4
16	Idle	2	8		0.8
17	Acceleration	3	7		0.7
18	Deceleration	2	8		0.8
19	Idle-Acceleration		10		1.0
20	Acceleration	2	7	1	0.9
21	Idle-Acceleration	3	7		0.7
22	Deceleration	2	8		0.8
23	Idle-Acceleration	2	8		0.8
24	Deceleration	1	9		0.9
25	Acceleration	4	6		0.6
26	Idle-Acceleration	4	6		0.6
27	Deceleration	2	8		0.8
28	Acceleration	4	6		0.6

TABLE 37C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT-673C
Operating Conditions: See Tables 27 through 32

Run No.	Operating Conditions	"O" Oily Responses		
		0	1	Avg
1	140 hp at 2100 rpm		10	1.0
2	140 hp at 1800 rpm		10	1.0
3	Idle	1	9	0.9
4	140 hp at 1500 rpm	1	9	0.9
5	Idle	1	9	0.9
6	140 hp at 1800 rpm		10	1.0
7	140 hp at 2100 rpm		10	1.0
8	140 hp at 1500 rpm		10	1.0
9	140 hp at 1500 rpm	1	9	0.9
10	Idle	1	9	0.9
11	140 hp at 1800 rpm		10	1.0
12	140 hp at 2100 rpm	1	9	0.9
13	140 hp at 1800 rpm	1	9	0.9
14	140 hp at 2100 rpm	2	8	0.8
15	140 hp at 1500 rpm	1	9	0.9
16	Idle	1	9	0.9
17	Acceleration	2	8	0.8
18	Deceleration	1	9	0.9
19	Idle-Acceleration	4	6	0.6
20	Acceleration	2	8	0.8
21	Idle-Acceleration	1	9	0.9
22	Deceleration	1	9	0.9
23	Idle-Acceleration		10	1.0
24	Deceleration		10	1.0
25	Acceleration		10	1.0
26	Idle-Acceleration	1	9	0.9
27	Deceleration		10	1.0
28	Acceleration		10	1.0

TABLE 37D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT-673C
Operating Conditions: See Tables 27 through 32

Run No.	Operating Conditions	"A" Aromatic Responses		
		0	1	Avg
1	140 hp at 2100 rpm	3	7	0.7
2	140 hp at 1800 rpm	1	9	0.9
3	Idle	1	9	0.9
4	140 hp at 1500 rpm	1	9	0.9
5	Idle	2	8	0.8
6	140 hp at 1800 rpm	3	7	0.7
7	140 hp at 2100 rpm	2	8	0.8
8	140 hp at 1500 rpm	2	8	0.8
9	140 hp at 1500 rpm	1	9	0.9
10	Idle	2	8	0.8
11	140 hp at 1800 rpm	1	9	0.9
12	140 hp at 2100 rpm	1	9	0.9
13	140 hp at 1800 rpm	1	9	0.9
14	140 hp at 2100 rpm		10	1.0
15	140 hp at 1500 rpm	3	7	0.7
16	Idle	1	9	0.9
17	Acceleration	3	7	0.7
18	Deceleration	2	8	0.8
19	Idle-Acceleration	1	9	0.9
20	Acceleration	2	8	0.8
21	Idle-Acceleration	3	7	0.7
22	Deceleration	1	9	0.9
23	Idle-Acceleration	1	9	0.9
24	Deceleration	1	9	0.9
25	Acceleration	4	6	0.6
26	Idle-Acceleration	3	7	0.7
27	Deceleration	5	5	0.5
28	Acceleration	6	4	0.4

TABLE 37E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT-673C
Operating Conditions: See Tables 27 through 32

Run No.	Operating Conditions	"P" Pungent Responses 0	1	Avg
1	140 hp at 2100 rpm	10		0
2	140 hp at 1800 rpm	9	1	0.1
3	Idle	9	1	0.1
4	140 hp at 1500 rpm	9	1	0.1
5	Idle	8	2	0.2
6	140 hp at 1800 rpm	7	3	0.3
7	140 hp at 2100 rpm	4	6	0.6
8	140 hp at 1500 rpm	7	3	0.3
9	140 hp at 1500 rpm	5	5	0.5
10	Idle	9	1	0.1
11	140 hp at 1800 rpm	7	3	0.3
12	140 hp at 2100 rpm	1	9	0.9
13	140 hp at 1800 rpm	1	9	0.9
14	140 hp at 2100 rpm	2	8	0.8
15	140 hp at 1500 rpm	1	9	0.9
16	Idle	2	8	0.8
17	Acceleration	10		0
18	Deceleration	9	1	0.1
19	Idle-Acceleration	6	4	0.4
20	Acceleration	6	4	0.4
21	Idle-Acceleration	7	3	0.3
22	Deceleration	8	2	0.2
23	Idle-Acceleration	6	4	0.4
24	Deceleration	7	3	0.3
25	Acceleration	7	3	0.3
26	Idle-Acceleration	7	3	0.3
27	Deceleration	7	3	0.3
28	Acceleration	9	1	0.1

TABLE 38. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT 673C
Operating Conditions: See Table 34

Constant Speed (all at maximum power)

Operating Conditions*	Engine Speed, rpm	Vehicle Ouput, obs hp	Vehicle Speed, mph	Transmission Drive Gear	PHS Smoke Reading, Percent Opacity Max	Min	Average
A	1100	103	37	14	35	32	33.5
B	1300	125	42	14	25	25	25.0
C	1500	155	48	14	17	16	16.5
D	1700	160	53	14	15	13	14.0
E	1900	173	59	14	11	9	10.0
F	2100	184	66	14	7	6	6.5
G	2200	160	70	14	6	6	6.0

Acceleration (40 hp at 30 mph preset and retained)

Operating Conditions	Transmission Gear No.	PHS Smoke Reading, Percent Opacity Max	Min	Average
H	7	44	30	35
	8	39	29	33
	10	36	31	33
	11	38	33	35
	12	34	30	32
	13	37	30	35

---

*See Tables 8 through 10 for details of operating procedures.

TABLE 39. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

Vehicle: 1961 Mack
Date: January 31, 1969

Engine: Mack ENDT 673C
Operating Conditions: See Table 28

Operating Conditions	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic* Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	SO_2, ppm	Adjusting Factor†
1500 rpm	2050	10.6	255	20.03	42.14	20.03	1605.45	1650	0.32	
140 hp	2050	10.4	232	24.03	38.69	24.03	1836.45	1650	0.35	
	2080	10.6	267	24.78	28.77	24.78	1617.00	1650	0.17	
	2050	9.9	220	4.64	30.91	5.05	877.80	1550	0.52	
"As-measured" average	258	10.4	244	18.37	35.13	18.47	1484.18	1625	0.34	
Adjusted average	372	15.98	351	26.45	50.59	26.60	2137.22	2340	0.49	1.44
1800 rpm	845	8.7	302	16.21	27.30	16.21	1362.90	1340	0.31	
140 hp	930	8.7	278	19.29	24.50	19.29	1397.55	1310	0.33	
	910	8.7	302	20.28	20.60	20.28	1386.00	1270	0.34	
	825	8.7	325	5.74	24.61	17.01	1085.70	1270	0.44	
"As-measured" average	878	8.7	302	15.36	24.25	18.20	1308.04	1298	0.36	
Adjusted average	1501	14.88	516	26.27	41.47	31.12	2236.75	2220	0.62	1.71
2100 rpm	825	7.7	232	11.00	28.16	11.00	1051.05	1070	0.23	
140 hp	780	7.5	302	25.53	35.71	25.53	1051.05	1070	0.44	
	780	7.7	313	12.80	32.74	12.80	924.00	1020	0.41	
	715	7.5	325	6.23	27.82	12.15	877.80	1020	0.52	
"As-measured" average	775	7.6	293	13.89	31.11	15.37	975.98	1045	0.40	
Adjusted average	1519	14.90	574	27.22	60.98	30.13	1912.92	2048	0.78	1.96
Idle	340	0.8	325	13.93	25.25	13.93	577.50	600	0.11	
	305	0.9	325	16.95	29.25	16.95	693.00	640	0.14	
	290	0.9	325	17.07	27.44	17.07	554.40	600	0.13	
	305	0.9	325	3.12	20.34	10.01	565.95	640	0.16	
"As-measured" average	310	0.9	325	12.77	25.57	14.49	597.71	620	0.14	
Adjusted average	4991	14.49	5233	205.60	411.68	233.29	9623.13	9982	2.25	16.1

---

*As ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO and CO_2) in the exhaust using "as-measured" CO and CO_2 measurements.

TABLE 40. DESCRIPTION OF DIESEL-POWERED TRUCK

Date Tested	June 25, 1969
Engine Data	
Manufacturer	Detroit Diesel General Motors
Engine Number	8V-71
Cycles	2
Horsepower Rating at 2100 rpm	280
Naturally Aspirated	Yes
Cylinders/Arrangement	8/V
Displacement, cubic inches	568
Bore and Stroke, inches	4-1/4 × 5
Number of Exhaust Valves	4
Type Injectors	Units
Injector Size	N 60
Engine Maintenance:	
Total Miles	12, 357
Miles since Injector Change	12, 357
Miles since Major Overhaul	12, 357
Tractor Data	
Manufacturer	International Harvester Company COF 4070A
Source	Hertz
Tractor Number	62364
Type	Cabover
Year	1969
Drive Line Data:	
Transmission	Fuller T345
Number of Forward Speeds	10
Rear Axle	Eaton Single
Rear Axle Ratio	4.44:1
Number of Drive Axles	2
Tire Size	10.00 × 20

TABLE 41. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel 8V-71 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Vehicle Speeds and Loads:	The following are to be run under 32,000-lb vehicle weight inertia simulation.

Vehicle Speed, mph	Drive Gear	Engine Speed, rpm	Vehicle Load, hp	Power Level
26	7	1500	160	Near maximum rack
31	7	1800	170	Near maximum rack
36	7	2100	180	Near maximum rack

Procedure:

(1) Operate at given stable engine and vehicle speed and load.

(2) Turn "on" panel alert light and turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation 45 seconds after light is turned "on" and maintain stable operation.

(4) Panel turns light "off" when evaluation is complete. The evaluation requires 50 to 70 seconds to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-second period.

(5) When panel turns "off" light, turn dilution system to "man" control and decelerate.

(6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 minutes; with 3-minute rest, 6 minutes.

TABLE 42. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel 8V-71 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Vehicle Speed and Load:	Engine idled at 575 rpm after 1 minute of operation in 8th gear at 42 mph, 180 hp and 1900-rpm engine speed.
Procedure:	(1) Operate vehicle in 8th gear at 42 mph, engine at 1900 rpm and producing 180 hp at rear wheels for 1 minute. (2) After 1 minute of stable operations, closed-rack decelerate to 30 mph and shift to neutral and allow engine to idle. (3) Turn "on" panel alert light and turn dilution system to "auto" when vehicle is shifted to neutral and engine is permitted to idle at 575 rpm. (4) Ring bell for panel exposure 30 seconds after beginning of engine idle and continue idle. (5) Panel turns light "off" when evaluation is complete. The evaluations require 50 to 70 seconds to complete. Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-second period. (6) When panel turns "off" light, turn dilution system to "man" control. (7) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")
Run Time:	Approximately 3 minutes; with 3-minute rest, 6 minutes.

TABLE 43. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel 8V-71 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axles.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	32,000-lb vehicle weight via SwRI System.
Vehicle Speed and Load:	Engine idle at 575 rpm followed by normal acceleration from 0 to 8 mph in 1st gear with 0 hp impressed in water brake dynamometer.
Procedure:	(1) Turn "on" panel alert light, start engine and idle and turn dilution system to "auto." (2) After 1 minute of idle, 575-rpm engine speed, accelerate in 1st gear. (Inertia simulation of 32,000-lb vehicle weight; 16,000 lb per each of two drive axles.) Power is applied gradually essentially as in normal truck operation. (3) Ring bell as engine speed crosses 1500 rpm on chart recorder (approximately 3 seconds after start of acceleration) for panel exposure. (4) Continue to accelerate to maximum engine and vehicle speed in 1st gear (2300 rpm and 8 mph), hold for 15 seconds, then shift to neutral and turn "off" engine. Turn "off" light. (5) Repeat items (1) through (4) above after 2-minute rest. The original and repeat idle-acceleration constitute one run. (6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time:	Approximately 4-1/2 minutes; with 3-minute rest, 7-1/2 minutes.

TABLE 44. ACCELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Detroit Diesel 8V-71 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 32,000-lb vehicle weight via SwRI System.

Vehicle Speed and Load: Full-rack acceleration from 43 to 53 mph in 9th gear with 80 hp initially preset in water brake dynamometer and retained.

Procedure:

(1) Operate in 8th gear at 2200-rpm engine speed, 48 mph, and preset 80 hp total into dynamometer.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) After 30 seconds of stable operation in 8th gear at 80 hp, upshift to 9th gear and full-rack accelerate to 62 mph, load retained in dynamometer.

(4) Ring bell for panel exposure on reaching 2100 rpm.

(5) Continue to accelerate in 9th gear to 62 mph, 2200-rpm engine speed, and hold for 15 seconds.

(6) Turn "off" light and turn dilution system to "man" and decelerate to a holding condition in 8th gear.

(7) Repeat items (1) through (5) above after 2-minute rest. The original and repeat constitute one run.

(8) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 5 minutes; with 3-minute rest, 8 minutes.

TABLE 45. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Tandem drive axle truck-tractor powered by a Detroit Diesel 8V-71 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axles.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 32, 000-lb vehicle weight via SwRI System.

Vehicle Speed and Load: Operate in 9th gear at 2100-rpm engine speed, 58-mph vehicle speed, 170 hp, for 1 minuted followed by closed-rack deceleration with load retained in water brake dynamometer.

Procedure:

(1) Operate in 9th gear at 2100-rpm engine speed and 58-mph vehicle speed at 170 hp.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) Continue to operate at stable constant-speed conditions for 1 minute and then closed-rack decelerate with load retained in water brake dynamometer.

(4) Ring bell for panel exposure 5 seconds after start of closed-rack deceleration.

(5) Continue deceleration another 10 seconds and then turn "off" light and turn dilution system to "man" control.

(6) Wait 2 minutes and repeat items (1) through (6) above. The original and repeat constitute one run.

(7) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6 minutes; with 3-minute rest, 8 minutes.

TABLE 46. CONSTANT SPEED SMOKE EVALUATION PROCEDURE

(Derating Experiments, Detroit Diesel 8V-71 Engine)

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel Division, General Motors Corporation 8V-71 N inline diesel engine through a Fuller 10-speed transmission and Eaton single-speed rear axles.
Measurement Method:	U. S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speeds and Loads:	Maximum vehicle smoke is to be measured at maximum power open-rack condition in 8th gear at 1500-, 1700-, 1900-, 2100-, and 2200-rpm engine speed. Rear axles locked. 32,000-lb vehicle inertia simulation.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and accelerate to 8th gear and operate at 1500-rpm open-rack. After measurement of smoke, release load to increase to 1700 rpm. After smoke measurement, release load and operate at 1900 rpm. Similarly measure smoke at 2100 and 2200 rpm engine speed. (3) Repeat items (1) and (2) two times. Note: Each smoke measurement should be preceded by 30 seconds of stable operation.

TABLE 47. ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	Tandem drive axle truck-tractor powered by a Detroit Diesel 8V-71 N diesel engine through a Fuller 10-speed transmission and Eaton single-speed rear axles.
Measurement Method:	U. S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speed and Load:	Full-rack acceleration from 5th into 6th into 7th into 8th into 9th into 10th gear under 32,000-lb inertia simulation and with 40 hp total (20 hp per axle) preset in the water brake dynamometer at 30 mph and retained.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and allow to idle. Note maximum smoke at start on recorder and continue idle for 1 minute. (3) Accelerate to 10th gear full-rack under normal type driving habit with 32,000-lb inertia simulation and the preset load of 40 hp at 30 mph. (4) Note the maximum smoke during each acceleration in 5th, 6th, 7th, 8th, 9th, and 10th gears. (5) Repeat steps (1) through (4) above two times.

TABLE 48. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: 1967 IHC Tractor
Date: June 25, 1969

Engine: Detroit Diesel 8V-71
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	1500 rpm at 160 hp	1.0	0.7	0.2	0.2	0
8	" "	1.5	0.8	0.3	0.3	0.2
10	" "	3.0	1.0	0.7	0.7	0
14	" "	2.5	1.0	0.7	0.7	0.3
		2.0	0.8	0.4	0.4	0.1
2	1800 rpm at 170 hp	1.7	0.7	0.3	0.8	0
5	" "	1.0	0.7	0.2	0.2	0
12	" "	1.0	0.5	0.2	0.3	0
13	" "	1.5	0.5	0.5	0.8	0.2
		1.3	0.6	0.3	0.5	0
1	2100 rpm at 180 hp	1.3	0.7	0.3	0.5	0
6	" "	1.3	0.5	0.3	0.2	0
11	" "	1.8	0.7	0.5	0.7	0
15	" "	1.5	0.7	0.3	0.5	0.2
		1.4	0.6	0.3	0.4	0
3	Idle	1.7	1.0	0.5	0.7	0
7	"	1.8	0.5	0.5	1.0	0.2
9	"	1.8	0.7	0.2	0.7	0.2
16	"	1.8	0.8	0.5	0.5	0.2
		1.8	0.7	0.4	0.7	0.2
17	Idle-Acceleration	1.8	0.8	0.5	0.5	0.2
20	" "	1.8	0.8	0.7	0.8	0.3
23	" "	2.2	1.0	0.5	0.3	0
26	" "	1.5	0.8	0.5	0.5	0
		1.8	0.8	0.6	0.5	0.1
19	Acceleration	1.2	0.7	0.2	0.2	0
22	"	2.8	1.0	1.0	0.3	0.2
25	"	1.8	1.0	0.5	0.5	0
28	"	2.8	1.2	0.8	0.5	0.2
		2.1	0.9	0.6	0.3	0.1
18	Deceleration	1.3	0.7	0.3	0.5	0
21	"	1.3	0.7	0.3	0.3	0
24	"	2.0	1.0	0.5	0.3	0
27	"	1.5	0.8	0.3	0.3	0.2
		1.5	0.8	0.3	0.3	0

TABLE 49. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: 1969 IHC Tractor
Date: June 23, 1969

Engine: Detroit Diesel 8V-71

Constant Speed (All at Maximum Power)

Engine Speed, rpm	Vehicle Output, obs hp	Vehicle Speed, mph	Transmission Drive Gear	PHS Smoke Readings, Percent Opacity		
				Max	Min	Avg
1500	160	26	8	4	3.5	3.7
1700	170	29	8	3.5	3	3.2
1900	180	32	8	3.5	2.5	2.8
2100	190	36	8	4	3	3.3
2200	200	38	8	4	3	3.3

Acceleration (40 hp at 30 mph preset and retained)

Transmission Gear No.	PHS Smoke Readings, Percent Opacity		
	Max	Min	Avg
5	3.5	3.0	3.3
6	3.5	2.5	3.0
7	3.5	2.5	3.0
8	3	2.5	2.8
9	2.5	2.2	2.4
10	3.5	3.5	3.5

TABLE 50 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: 1969 IHC Tractor
Date: June 25, 1969

Engine: Detroit Diesel 8V-71

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
1500 rpm	4	1690	6.6	195	2.5	16.9	6.0	1259	1260	54
26 mph	8	2260	7.3	156	2.8	17.1	6.1	1086	1160	58
160 hp	10	2450	7.1	209	2.9	17.1	7.6	1386	1180	56
	14	2080	6.9	219	2.8	20.6	7.8	1271	1320	49
Average		2120	6.9	195	3	18	7	1250	1230	54
1800 rpm	2	890	6.9	209	2.3	14.9	5.2	1063	1310	54
31 mph	5	820	6.9	221	2.4	17.1	6.1	1190	1310	49
170 hp	12	610	6.6	207	2.4	19.3	6.9	1167	1290	51
	13	890	6.8	195	2.3	20.3	6.9	1178	1310	51
Average		802	6.8	208	2	18	6	1149	1305	51
2100 rpm	1	845	6.6	234	2.0	14.9	6.0	1016	1140	49
36 mph	6	715	6.7	247	2.3	14.9	6.0	982	1100	47
180 hp	11	910	6.8	247	2.5	17.1	6.8	1040	1100	49
	15	845	6.6	221	2.4	18.5	7.8	936	1160	51
Average		828	6.6	237	2	16	7	993	1125	49
Idle	3	165	1.0	207	1.9	15.9	3.8	347	480	32
	7	139	0.9	166	2.1	17.9	4.5	277	300	35
	9	165	0.9	207	2.2	20.1	6.1	266	350	32
	16	150	1.0	193	2.2	17.7	5.5	243	350	33
Average		154	0.9	193	2	18	5	283	370	33

TABLE 51. DESCRIPTION OF DIESEL-POWERED TRUCK

Date Tested: July 22, 1969

Engine Make: Cummins

No. Cyl/Cycle: 6/4

BHP at rpm: 250/2100 derated to 225 hp at 2100

Displacement, cubic inches: 855

Bore and Stroke, inches: 5-1/2 × 6

Turbo/Naturally Aspirated: Naturally Aspirated

Tractor Source: Ryder Truck Rental

Tractor Mileage: 105, 770

Tractor Make: Ford

Cabover/Conv: Cabover

Tractor Model/Year: HDT-950/1968

Transmission Make: Fuller

Transmission Model: RT9-10

Transmission Speeds: 10

Rear Axle Make: Eaton

No. of Drive/Dead Axles: 1/0

No. of Axle Speeds: 1

Tire Size: 10.00 × 20

TABLE 52. CONSTANT SPEED DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Two axle truck-tractor powered by a derated Cummins NH-250 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Vehicle Speeds and Loads: The following are to be run under 25,000-lb vehicle weight inertia simulation:

Vehicle Speed, mph	Drive Gear	Engine Speed, rpm	Vehicle Load, hp	Power Level
39	9	1500	150	Near Maximum
38	8	1800	150	Near Maximum
35	7	2100	150	Near Maximum

Procedure:

(1) Operate at given stable engine and vehicle speed and load.

(2) Turn "on" panel alert light and turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation 45 seconds after light is turned "on" and maintain stable operation.

(4) Panel turns light "off" when evaluation is complete. The evaluation requires 50 to 70 seconds to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-second period.

(5) When panel turns "off" light, turn dilution system to "man" control and decelerate.

(6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 minutes; with 3-minute rest, 6 minutes.

TABLE 53. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Two axle truck-tractor powered by a derated Cummins NH-250 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Vehicle Speed and Load:	Engine idled at 575 rpm after 1 minute of operation in 8th gear at 40 mph, 150 hp and 1900-rpm engine speed.

Procedure:

(1) Operate vehicle in 8th gear at 40 mph, engine at 1900 rpm and producing 150 hp at rear wheels for 1 minute.

(2) After 1 minute of stable operation, closed-rack decelerate to 30 mph and shift to neutral and allow engine to idle.

(3) Turn "on" panel alert light and turn dilution system to "auto" when vehicle is shifted to neutral and engine is permitted to idle at 575 rpm.

(4) Ring bell for panel exposure 30 seconds after beginning of engine idle and continue idle.

(5) Panel turns light "off" when evaluation is complete. The evaluations require 50 to 70 seconds to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-second period.

(6) When panel turns "off" light, turn dilution system to "man" control.

(7) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 minutes; with 3-minute rest, 6 minutes.

TABLE 54. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability:	Two axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	25, 000-lb vehicle weight via SwRI System.
Vehicle Speed:	Engine idle at 575 rpm followed by normal acceleration from 0 to 9 mph in 1st gear with 0 hp preset in water brake dynamometer.
Procedure:	(1) Turn "on" panel alert light, start engine and idle and turn dilution system to "auto." (2) After 1 minute of idle, 575-rpm engine speed, accelerate in 1st gear. (Inertia simulation of 25, 000-lb vehicle weight.) Power is applied gradually essentially as in normal truck operation. (3) Ring bell as engine speed crosses 1500 rpm on chart recorder (approximately 3 seconds after start of acceleration) for panel exposure. (4) Continue to accelerate to maximum engine and vehicle speed in 1st gear (2300 rpm and 9 mph), hold for 15 seconds, then shift to neutral and turn "off" engine. Turn "off" light. (5) Repeat items (1) through (4) above after 2-minute rest. The original and repeat idle-acceleration constitute one run. (6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time:	Approximately 4-1/2 minutes; with 3-minute rest, 7-1/2 minutes.

TABLE 55. ACCELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Two axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 25,000-lb vehicle weight via SwRI System.

Vehicle Speed and Load: Full-rack acceleration from 46 to 58 mph in 9th gear with 60 hp initially preset in water brake dynamometer and retained.

Procedure:

(1) Operate in 8th gear at 2200-rpm engine speed, 46 mph, and preset 60 hp into dynamometer.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) After 30 seconds of stable operation in 8th gear at 60 hp, upshift to 9th gear and full-rack accelerate to 58 mph, load retained in dynamometer.

(4) Ring bell for panel exposure on reaching 2100 rpm.

(5) Continue to accelerate in 9th gear to 58 mph, 2200-rpm engine speed, and hold for 15 seconds.

(6) Turn "off" light and turn dilution system to "man" and decelerate to a holding condition in 8th gear.

(7) Repeat items (1) through (5) above after 2-minute rest. The original and repeat constitute one run.

(8) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 5 minutes; with 3-minute rest, 8 minutes.

TABLE 56. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: Two axle truck-tractor powered by a Cummins NH-250 diesel engine through Fuller 10-speed transmission and Eaton single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Inertia Simulation: 25,000-lb vehicle weight via SwRI System.

Vehicle Speed and Load: Operate in 9th gear at 2100-rpm engine speed, 56-mph vehicle speed, at near open-rack, 160 hp, for 1 minute followed by closed-rack deceleration with load retained in water brake dynamometer.

Procedure:

(1) Operate in 9th gear at 2100-rpm engine speed and 56-mph vehicle speed at near open-rack, 160 hp.

(2) Turn "on" panel alert light and turn dilution system to "auto" control.

(3) Continue to operate at stable constant-speed conditions for 1 minute and then closed-rack decelerate with load retained in water brake dynamometer.

(4) Ring bell for panel exposure 5 seconds after start of closed-rack deceleration.

(5) Continue deceleration another 10 seconds and then turn "off" light and turn dilution system to "man" control.

(6) Wait 2 minutes and repeat items (1) through (6) above. The original and repeat constitute one run.

(7) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6 minutes; with 3-minute rest, 8 minutes.

TABLE 57. CONSTANT SPEED SMOKE EVALUATION PROCEDURE

Applicability:	Two-axle truck-tractor powered by a derated Cummins NH-250 diesel engine through a Fuller 10-speed transmission and Eaton single-speed rear axle.
Measurement Method:	U. S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speeds and Loads:	Maximum vehicle smoke is to be measured at maximum power open-rack condition in 8th gear at 1500-, 1700-, 1900-, 2100-, and 2200-rpm engine speed with 25,000-lb vehicle inertia simulation.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and accelerate to 8th gear and operate at 1500-rpm open rack. After measurement of smoke, release load to increase to 1700 rpm. After smoke measurement, release load and operate at 1900 rpm. Similarly measure smoke at 2100-, and 2200-rpm engine speed. (3) Repeat items (1) and (2) two times. Note: Each smoke measurement should be preceded by 30 seconds of stable operation.

TABLE 58. ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	Two axle truck-tractor powered by a derated Cummins NH-250 diesel engine through a Fuller 10-speed transmission and Eaton single-speed rear axle.
Measurement Method:	U.S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speed and Load:	Full-rack acceleration from 5th into 6th into 7th into 8th into 9th into 10th gear under 25,000-lb inertia simulation and with 40 hp total (20 hp per axle) preset in the water brake dynamometer at 30 mph and retained.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and allow to idle. Note maximum smoke at start on recorder and continue idle for 1 minute. (3) Accelerate to 10th gear full rack under normal type driving habit with 25,000-lb inertia simulation and the preset load of 40 hp at 30 mph. (4) Note the maximum smoke during each acceleration in 5th, 6th, 7th, 8th, 9th, and 10th gears. (5) Repeat steps (1) through (4) above two times.

TABLE 59. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: 1968 Ford Tractor
Date: July 22, 1969

Engine: Cummins NH-250 derated to 225
Fuel: EM-90-F (No. 2 Diesel)
Dilution Ratio: 700:1

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	1500 rpm at 150 hp	1.3	0.6	0.4	0.4	0
5	" "	2.0	0.7	0.7	0.7	0.1
10	" "	2.0	1.0	1.0	0.4	0
13	" "	2.6	1.0	1.0	0.7	0
		2.0	0.8	0.8	0.6	0
3	1800 rpm at 150 hp	2.3	1.0	0.6	0.6	0.1
7	" "	1.9	0.7	0.9	0.7	0.1
9	" "	1.4	0.6	0.9	0.7	0
15	" "	2.0	0.7	0.9	0.6	0
		1.9	0.8	0.8	0.7	0.1
2	2100 rpm at 150 hp	1.7	0.9	0.6	0.6	0
8	" "	2.0	0.9	0.7	0.4	0
12	" "	1.4	0.6	0.7	0.7	0.1
16	" "	1.6	0.6	0.9	0.7	0
		1.7	0.8	0.7	0.6	0
4	Idle	2.7	1.0	0.7	0.6	0.1
6	"	1.4	0.7	0.9	0.6	0.1
11	"	2.6	0.7	1.0	0.7	0.1
14	"	1.7	0.6	0.9	0.6	0
		2.1	0.8	0.9	0.6	0.1
17	Idle-Acceleration	0.9	0.3	0.1	0.3	0
20	" "	2.6	0.9	1.0	0.9	0.6
23	" "	1.7	0.9	0.7	0.9	0.3
26	" "	2.1	0.9	0.9	0.9	0
		1.8	0.8	0.7	0.8	0.2
18	Acceleration	1.1	0.3	0.4	0.4	0
21	"	1.6	0.7	0.9	0.7	0.1
25	"	1.9	0.9	0.7	0.9	0
27	"	1.9	1.0	0.7	0.9	0.1
		1.6	0.7	0.7	0.7	0.1
19	Deceleration	4.0	1.1	1.1	1.1	0.6
22	"	3.1	1.1	1.1	0.7	0.3
24	"	3.1	0.9	1.0	0.9	0.6
28	"	1.9	0.7	1.0	1.0	0
		3.0	1.0	1.1	0.9	0.4

TABLE 60. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: 1968 Ford Tractor	Engine: Cummins NH-250
Date: July 22, 1969	Fuel: EM-90-F (No. 2 Diesel) derated to 225

Constant Speed (all at maximum power)

Engine Speed, rpm	Vehicle Output, obs hp	Vehicle Speed, mph	Transmission Drive Range	PHS Smoke Reading, Percent Opacity		
				Max	Min	Avg
1500	150	31	8	7	7	7.0
1700	165	35	8	9	8.5	8.8
1900	190	40	8	10.5	10	10.3
2100	184	43	8	11	11	11.0
2200	150	45	8	8	8	8.0

Acceleration (40 hp at 30 mph preset and retained)

Transmission Gear No.	PHS Smoke Reading, Percent Opacity		
	Max	Min	Avg
5	5	5	5.0
6	6	5.5	6.8
7	10	9.5	9.8
8	10.5	10	10.3
9	9	8.5	8.8
10	7	6.5	6.8

TABLE 61. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: 1968 Ford Tractor
Date: July 22, 1969

Engine: Cummins NH-250 derated to 225
Fuel: EM-90-F (No. 2 Diesel)

Operating Conditions	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
1500 rpm	2200	10.4	38	1.6	15.9	3.0	1698	1600	--
150 hp	2200	10.2	50	1.5	12.8	3.2	1675	1425	--
	2200	10.2	25	2.1	16.1	7.3	1617	1375	--
	2200	10.2	25	1.8	15.0	4.1	1640	1425	--
Average	2200	10.2	35	2	15	4	1658	1456	--
1800 rpm	710	8.0	51	2.4	19.0	8.8	1224	1025	--
150 hp	730	7.7	51	3.0	19.7	7.9	1271	975	--
	850	8.2	26	3.3	23.4	10.5	1224	975	--
	670	7.7	39	1.9	17.0	4.8	1201	1025	--
Average	740	7.9	42	3	20	8	1230	1000	--
2100 rpm	730	7.7	51	3.0	17.1	6.1	820	750	--
150 hp	710	7.3	64	3.7	26.4	13.6	959	725	--
	590	7.3	26	2.1	20.9	5.9	889	750	--
	650	7.3	39	2.7	19.4	8.2	924	790	--
Average	670	7.4	45	3	21	9	898	754	--
Idle	160	0.8	84	2.1	20.9	8.7	116	150	--
0 hp	180	0.8	55	1.6	22.0	8.0	104	150	--
	160	0.8	42	1.4	21.1	6.4	104	100	--
	160	0.8	42	1.5	19.1	4.8	116	150	--
Average	165	0.8	56	2	21	7	110	138	--

TABLE 62. DESCRIPTION OF DIESEL-POWERED TRUCK

Date Tested: August 5, 1969

Engine Make: Cummins NH-220

No. Cyl/Cycle: 6/4

BHP at rpm: 220/2100

Displacement, cubic inches: 743

Bore and Stroke, inches: 5-1/8 × 6

Turbo/Naturally Aspirated:

Tractor Source: ABC Rental Agency

Tractor Mileage: 172, 480

Mileage Since Injector Change: 60, 920

Tractor Make: White Freightliner

Cabover/Conv: Cabover

Tractor Model/Year: WFT 7542T/1965

Transmission Make: Fuller

Transmission Model: Road Ranger

Transmission Speeds: 10

Rear Axle Make: Eaton

No. of Drive/Dead Axles: 1/1

No. of Axle Speeds: 1

Tire Size: 10.00 × 20

TABLE 63. CONSTANT SPEED DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: Three axle truck-tractor powered by a Cummins NH-220 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.

Sample Method: Constant sample flow at 700:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.

Vehicle Speeds and Loads: The following are to be run under 25,000-lb vehicle weight inertia simulation:

Vehicle Speed, mph	Drive Gear	Engine Speed, rpm	Vehicle Load, hp	Power Level
38	9	1500	150	Near maximum
37	8	1800	150	Near maximum
34	7	2100	150	Near maximum

Procedure:

(1) Operate at given stable engine and vehicle speed and load.

(2) Turn "on" panel alert light and turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation 45 seconds after light is turned "on" and maintain stable operation.

(4) Panel turns light "off" when evaluation is complete. The evaluation requires 50 to 70 seconds to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-second period.

(5) When panel turns "off" light, turn dilution system to "man" control and decelerate.

(6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

Run Time: Approximately 3 minutes, with 3-minute rest, 6 minutes.

TABLE 64. IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Three axle truck-tractor powered by a Cummins NH-220 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Vehicle Speed and Load:	Engine idled after 1 minute of operation in 8th gear at 39 mph, 150 hp and 1900-rpm engine speed.
Procedure:	(1) Operate vehicle in 8th gear at 39 mph, engine at 1900 rpm and producing 150 hp at rear wheels for 1 minute. (2) After 1 minute of stable operation, closed-rack decelerate to 30 mph and shift to neutral and allow engine to idle. (3) Turn "on" panel alert light and turn dilution system to "auto" when vehicle is shifted to neutral and engine is permitted to idle. (4) Ring bell for panel exposure 30 seconds after beginning of engine idle and continue idle. (5) Panel turns light "off" when evaluation is complete. The evaluations require 50 to 70 seconds to complete. Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with two to three exposures (sniffs) at will during the approximately 60-second period. (6) When panel turns "off" light, turn dilution system to "man" control. (7) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")
Run Time:	Approximately 3 minutes; with 3-minute rest, 6 minutes.

TABLE 65. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability:	Three axle truck-tractor powered by a Cummins NH-220 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	25,000-lb vehicle weight via SwRI System.
Vehicle Speed and Load:	Engine idle followed by normal acceleration from 0 to 9 mph in 1st gear with 0 hp preset in water brake dynamometer.
Procedure:	(1) Turn "on" panel alert light, start engine and idle and turn dilution system to "auto." (2) After 1 minute of idle, accelerate in 1st gear. (Inertia simulation of 25,000-lb vehicle weight.) Power is applied gradually essentially as in normal truck operation. (3) Ring bell as engine speed crosses 1500 rpm on chart recorder (approximately 3 seconds after start of acceleration) for panel exposure. (4) Continue to accelerate to maximum engine and vehicle speed in 1st gear (2300 rpm and 9 mph), hold for 15 seconds, then shift to neutral and turn "off" engine. Turn "off" light. (5) Repeat items (1) through (4) above after 2-minute rest. The original and repeat idle-acceleration constitute one run. (6) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 4-1/2 minutes, with 3-minute rest, 7-1/2 minutes.

TABLE 66. ACCELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Three axle truck-tractor powered by a Cummins NH-220 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	25,000-lb vehicle weight via SwRI System.
Vehicle Speed and Load:	Full-rack acceleration from 43 to 56 mph in 9th gear with 60 hp initially preset in water brake dynamometer and retained.
Procedure:	(1) Operate in 8th gear at 2200-rpm engine speed, 43 mph, and preset 60 hp into dynamometer. (2) Turn "on" panel alert light and turn dilution system to "auto" control. (3) After 30 seconds of stable operation in 8th gear at 60 hp, upshift to 9th gear and full-rack accelerate to 56 mph, load retained in dynamometer. (4) Ring bell for panel exposure on reaching 2100 rpm. (5) Continue to accelerate in 9th gear to 56 mph, 2200-rpm engine speed, and hold for 15 seconds. (6) Turn "off" light and turn dilution system to "man" and decelerate to a holding condition in 8th gear. (7) Repeat items (1) through (5) above after 2-minute rest. The original and repeat constitute one run. (8) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 5 minutes; with 3-minute rest, 8 minutes.

TABLE 67. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	Three axle truck-tractor powered by a Cummins NH-220 diesel engine through Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.
Sample Method:	Constant sample flow at 700:1 dilution level.
Warm-up:	A minimum of three runs should be conducted prior to odor evaluation to assure the engine and drive line systems have reached operating temperature.
Inertia Simulation:	25,000-lb vehicle weight via SwRI System.
Vehicle Speed and Load:	Operate in 9th gear at 2100-rpm engine speed, 54-mph vehicle speed, at near open-rack, 160 hp, for 1 minute followed by closed-rack deceleration with load retained in water brake dynamometer.
Procedure:	(1) Operate in 9th gear at 2100-rpm engine speed and 54-mph vehicle speed at near open-rack, 160 hp. (2) Turn "on" panel alert light and turn dilution system to "auto" control. (3) Continue to operate at stable constant-speed conditions for 1 minute and then closed-rack decelerate with load retained in water brake dynamometer. (4) Ring bell for panel exposure 5 seconds after start of closed-rack deceleration. (5) Continue deceleration another 10 seconds and then turn "off" light and turn dilution system to "man" control. (6) Wait 2 minutes and repeat items (1) through (6) above. The original and repeat constitute one run. (7) Wait 3 minutes between runs for panel rest and orifice change. (Time starts when light is turned "off" and should end when light is turned back "on.")

NOTE: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6 minutes, with 3-minute rest, 8 minutes.

TABLE 68. CONSTANT SPEED SMOKE EVALUATION PROCEDURE

Applicability:	Three axle truck-tractor powered by a Cummins NH-220 diesel engine through a Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.
Measurement Method:	U.S. Public Health Service full-flow light extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speeds and Loads:	Maximum vehicle smoke is to be measured at maximum power open-rack condition in 8th gear at 1500, 1700, 1900, 2100, and 2200-rpm engine speed. 25,000-lb vehicle inertia simulation.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and accelerate to 8th gear and operate at 1500-rpm open rack. After measurement of smoke, release load to increase to 1700 rpm. After smoke measurement, release load and operate at 1900, 2100, and 2200-rpm engine speed. (3) Repeat items (1) and (2) two times. Note: Each smoke measurement should be preceded by 30 seconds of stable operation.

TABLE 69. ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	Three axle truck-tractor powered by a Cummins NH-220 diesel engine through a Fuller 10-speed Road Ranger transmission and Eaton single-speed rear axle.
Measurement Method:	U.S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches above stack.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature.
Vehicle Speed and Load:	Full-rack acceleration from 5th into 6th into 7th into 8th into 9th into 10th gear under 25,000-lb inertia simulation and with 40 hp preset in the water brake dynamometer at 30 mph and retained.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 cfm of purge air. (2) Start engine and allow to idle. Note maximum smoke at start on recorder and continue idle for 1 minute. (3) Accelerate to 10th gear full rack under normal type driving habit with 25,000-lb inertia simulation and the preset load of 40 hp at 30 mph. (4) Note the maximum smoke during each acceleration in 5th, 6th, 7th, 8th, 9th, and 10th gears. (5) Repeat steps (1) through (4) above two times.

TABLE 70. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: 1965 White Freightliner
Date: August 5, 1969

Engine: Cummins NH-220
Fuel: EM-90-F (No. 2 Diesel)
Dilution Ratio: 700:1

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	1500 rpm at 150 hp	1.8	0.6	0.8	0.8	0.2
6	" "	2.6	0.9	1.0	0.7	0.4
12	" "	2.7	1.0	1.0	0.8	0.2
14	" "	3.6	1.0	0.9	0.9	0.8
		2.7	0.9	0.9	0.8	0.4
2	1800 rpm at 150 hp	3.7	1.0	1.0	0.9	0.3
8	" "	2.0	0.8	1.0	0.8	0.4
9	" "	2.6	1.0	0.9	0.8	0.3
13	" "	2.8	1.0	1.0	0.9	0.2
		2.8	1.0	1.0	0.9	0.3
3	2100 rpm at 150 hp	3.2	1.0	0.9	0.8	0.2
7	" "	1.7	1.0	0.9	0.8	0.1
10	" "	3.7	1.0	1.0	0.6	0.4
15	" "	3.4	1.0	0.9	0.9	0.2
		3.0	1.0	0.9	0.8	0.2
4	Idle	4.1	1.1	1.0	1.0	0.7
5	"	3.6	0.9	1.0	0.8	0.3
11	"	4.1	1.0	0.9	0.7	0.6
16	"	3.7	1.0	0.9	1.0	0.4
		3.9	1.0	1.0	0.9	0.5
19	Idle-Acceleration	3.6	1.0	1.0	0.9	0.8
21	" "	2.8	1.0	1.0	0.9	0.4
24	" "	3.3	1.0	1.0	0.9	0.4
26	" "	3.0	1.0	1.0	0.9	0.7
		3.2	1.0	1.0	0.9	0.6
18	Acceleration	2.2	0.8	0.9	0.9	0.2
23	"	2.7	1.0	1.0	0.9	0.4
25	"	3.3	1.0	1.0	0.8	0.7
28	"	3.0	1.0	1.0	1.0	0.4
		2.8	1.0	1.0	0.9	0.4
17	Deceleration	3.9	1.1	1.2	1.0	0.9
20	"	3.1	1.1	1.1	1.1	0.4
22	"	3.1	0.9	1.1	0.8	0.4
27	"	3.8	1.0	1.0	0.8	0.7
		3.5	1.0	1.1	0.9	0.6

TABLE 71. VEHICLE SMOKE EVALUATION SUMMARY

Vehicle: 1965 White Freightliner
Date: August 6, 1969

Engine: Cummins NH-220
Fuel: EM-90-F (No. 2 Diesel)

Constant Speed (all at maximum power)

Engine Speed, rpm	Vehicle Output, obs hp	Transmission Drive Range	PHS Smoke Reading, Percent Opacity Max	Min	Avg
1500	150	9	21	19	20.3
1700	160	9	23	23	23.0
1900	165	9	31	27	29.0
2100	170	9	30	26	28.0
2200	180	9	30	23	27.3

Acceleration (40 hp at 30 mph preset and retained)

Transmission Gear No.	PHS Smoke Reading, Percent Opacity Max	Min	Avg
5	11	11	11.0
6	11	9	10.0
7	15	13	14.0
8	23	23	23.0
9	26	24	25.0
10	19	19	19.0

TABLE 72. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: 1965 White Freightliner
Date: August 5, 1969

Engine: Cummins NH-220
Fuel: EM-90-F (No. 2 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1500 rpm	1	2000	10.4	286	2.0	9.4	2.0	1559	1450
150 hp	6	2000	10.4	213	1.7	10.7	6.0	1548	1425
	12	2000	10.6	263	1.5	7.7	0.7	1525	1475
	14	2000	10.7	273	1.1	7.7	0	1398	1525
Average		2000	10.5	259	2	9	3	1508	1469
1800 rpm	2	2000	9.4	338	1.9	8.1	1.4	1178	1075
150 hp	8	2000	10.4	350	3.2	9.8	4.9	1201	1275
	9	2000	10.1	240	3.3	8.2	2.7	1259	1250
	13	2000	9.7	306	1.5	7.9	0	1282	1200
Average		2000	9.9	309	3	9	2	1230	1200
2100 rpm	3	1941	9.3	493	2.3	8.8	2.0	912	750
150 hp	7	1776	8.1	343	2.9	10.1	4.7	832	775
	10	2000	10.1	353	2.5	7.5	1.4	924	925
	15	2000	10.1	376	3.7	7.7	0	970	975
Average		1929	9.4	391	3	9	2	910	854
Idle	4	194	1.5	484	1.6	10.8	4.0	116	175
	5	194	1.6	553	1.9	11.5	4.0	127	175
	11	164	1.5	235	1.5	9.5	2.7	127	200
	16	149	1.3	207	2.3	10.4	1.4	139	225
Average		175	1.5	370	2	11	3	127	194

APPENDIX E

VARIOUS DIESEL EMISSIONS MEASUREMENTS

BUREAU OF MINES AND SOUTHWEST RESEARCH INSTITUTE ODOR PANEL CORRELATION

Preceding page blank

TABLE 1A. VEHICLE ODOR EVALUATION RESULTS-- BUREAU OF MINES PANEL

("D" Diesel Composite Results)

Date: September 10, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"D" Diesel Composite Responses 2	3	4	4-1/2	5	6	7	8	Average
1	6V-71E	2	100:1	40 hp at 20 mph			1	2	1				3.4
2	6V-71E	2	100:1	40 hp at 20 mph			3		1				4.3
3	6V-71E	2	100:1	Idle					4				5.0
4	6V-71E	2	100:1	Idle			2		2				4.5
5	6V-71E	2	100:1	40 hp at 20 mph						4			6.0
6	6V-71E	2	100:1	Idle	1	2	1						3.0
7	6V-71E	2	100:1	Idle			1		1	2			5.3
8	6V-71E	2	100:1	40 hp at 20 mph							4		7.0
9	6V-71E	2	100:1	Idle					1	3			5.8
10	6V-71E	2	100:1	40 hp at 40 mph					2	2			5.5
11	6V-71E	2	100:1	50 hp at 1800 rpm			3		1				4.3
12	NH-220	4	100:1	150 hp at 1800 rpm			3		1				4.3
13	NH-220	4	100:1	Idle						4			6.0
14	NH-220	4	100:1	150 hp at 1800 rpm						4			6.0
15	NH-220	4	100:1	Idle		1	3						3.8
16	NH-220	4	100:1	50 hp at 1800 rpm					4				5.0
17	NH-220	4	100:1	150 hp at 1800 rpm				Void					--
18	NH-220	4	100:1	Idle					2	2			5.5
19	NH-220	4	100:1	50 hp at 1800 rpm			1		3				4.8
20	NH-220	4	100:1	Idle			2		2				4.5
21	NH-220	4	100:1	50 hp at 1800 rpm					1	3			5.8
22	NH-220	4	100:1	150 hp at 1800 rpm			1		2	1			5.0
23	6V-71E	2	100:1	40 hp at 40 mph							4		7.0
24	6V-71E	2	100:1	Idle		1	3						3.8
25	6V-71E	2	100:1	40 hp at 40 mph						1	3		6.8
26	6V-71E	2	100:1	Idle					4				5.0
27	6V-71E	2	100:1	40 hp at 40 mph							3	1	6.3
28	6V-71E	2	100:1	Idle			4						4.0

TABLE 1B. VEHICLE ODOR EVALUATION RESULTS--BUREAU OF MINES PANEL

("B" Burnt-Smoky Standard)

Date: September 10, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"B" Burnt-Smoky Responses					
					0	1/2	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph			1	3		1.8
2	6V-71E	2	100:1	40 hp at 20 mph			3	1		1.3
3	6V-71E	2	100:1	Idle	2	2				0.3
4	6V-71E	2	100:1	Idle	2	1	1			0.4
5	6V-71E	2	100:1	40 hp at 20 mph				4		2.0
6	6V-71E	2	100:1	Idle	4					0
7	6V-71E	2	100:1	Idle	4					0
8	6V-71E	2	100:1	40 hp at 20 mph					4	3.0
9	6V-71E	2	100:1	Idle	4					0
10	6V-71E	2	100:1	40 hp at 40 mph				1	3	2.8
11	NH-220	4	100:1	50 hp at 1800 rpm				4		2.0
12	NH-220	4	100:1	150 hp at 1800 rpm					4	3.0
13	NH-220	4	100:1	Idle			4			1.0
14	NH-220	4	100:1	150 hp at 1800 rpm					4	3.0
15	NH-220	4	100:1	Idle	4					0
16	NH-220	4	100:1	50 hp at 1800 rpm				3	1	2.3
17	NH-220	4	100:1	150 hp at 1800 rpm			Void			--
18	NH-220	4	100:1	Idle	3		1			0.3
19	NH-220	4	100:1	50 hp at 1800 rpm				3	1	2.3
20	NH-220	4	100:1	Idle	2		2			0.5
21	NH-220	4	100:1	50 hp at 1800 rpm				4		2.0
22	NH-220	4	100:1	150 hp at 1800 rpm			1	2	1	2.0
23	6V-71E	2	100:1	40 hp at 40 mph					4	3.0
24	6V-71E	2	100:1	Idle		1	3			0.9
25	6V-71E	2	100:1	40 hp at 40 mph					4	3.0
26	6V-71E	2	100:1	Idle	4					0
27	6V-71E	2	100:1	40 hp at 40 mph			2		2	2.0
28	6V-71E	2	100:1	Idle	2		2			0.5

TABLE 1C. VEHICLE ODOR EVALUATION RESULTS -- BUREAU OF MINES PANEL

("O" Oily Standard)

Date: September 10, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"O" Oily Standard					
					0	1/2	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph			4			1.0
2	6V-71E	2	100:1	40 hp at 20 mph			4			1.0
3	6V-71E	2	100:1	Idle				4		2.0
4	6V-71E	2	100:1	Idle				4		2.0
5	6V-71E	2	100:1	40 hp at 20 mph			1	3		1.8
6	6V-71E	2	100:1	Idle			3	1		1.3
7	6V-71E	2	100:1	Idle				2	2	2.5
8	6V-71E	2	100:1	40 hp at 20 mph				4		2.0
9	6V-71E	2	100:1	Idle				1	3	2.8
10	6V-71E	2	100:1	40 hp at 40 mph	2	1	1			0.4
11	NH-220	4	100:1	50 hp at 1800 rpm			1	3		1.8
12	NH-220	4	100:1	150 hp at 1800 rpm	3		1			0.3
13	NH-220	4	100:1	Idle				4		2.0
14	NH-220	4	100:1	150 hp at 1800 rpm			3	1		1.3
15	NH-220	4	100:1	Idle				2	2	2.5
16	NH-220	4	100:1	50 hp at 1800 rpm			4			1.0
17	NH-220	4	100:1	150 hp at 1800 rpm			Void			--
18	NH-220	4	100:1	Idle				3	1	2.3
19	NH-220	4	100:1	50 hp at 1800 rpm			2	2		1.5
20	NH-220	4	100:1	Idle				4		2.0
21	NH-220	4	100:1	50 hp at 1800 rpm			1	3		1.8
22	NH-220	4	100:1	150 hp at 1800 rpm			2	2		1.5
23	6V-71E	2	100:1	40 hp at 40 mph			2	2		1.5
24	6V-71E	2	100:1	Idle		1	3			0.9
25	6V-71E	2	100:1	40 hp at 40 mph			3	1		1.3
26	6V-71E	2	100:1	Idle				4		2.0
27	6V-71E	2	100:1	40 hp at 40 mph				3	1	2.3
28	6V-71E	2	100:1	Idle				4		2.0

TABLE 1D. VEHICLE ODOR EVALUATION RESULTS-- BUREAU OF MINES PANEL

("A" Aromatic Standard)

Date: September 10, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Condition	"A" Aromatic Responses 0	1/2	1	2	3	4	Average
1	6V-71E	2	100:1	40 hp at 20 mph			2	2			1.5
2	6V-71E	2	100:1	40 hp at 20 mph				3	1		2.3
3	6V-71E	2	100:1	Idle					4		3.0
4	6V-71E	2	100:1	Idle				3	1		2.3
5	6V-71E	2	100:1	40 hp at 20 mph				3	1		2.3
6	6V-71E	2	100:1	Idle			1	3			1.8
7	6V-71E	2	100:1	Idle				1	3		2.8
8	6V-71E	2	100:1	40 hp at 20 mph				4			2.0
9	6V-71E	2	100:1	Idle					4		3.0
10	6V-71E	2	100:1	40 hp at 40 mph				3	1		2.3
11	NH-220	4	100:1	50 hp at 1800 rpm	2		2				0.5
12	NH-220	4	100:1	150 hp at 1800 rpm			4				1.0
13	NH-220	4	100:1	Idle					4		3.0
14	NH-220	4	100:1	150 hp at 1800 rpm			1	3			1.8
15	NH-220	4	100:1	Idle			3	1			1.3
16	NH-220	4	100:1	50 hp at 1800 rpm			2	2			1.5
17	NH-220	4	100:1	150 hp at 1800 rpm			Void				--
18	NH-220	4	100:1	Idle				1	3		2.8
19	NH-220	4	100:1	50 hp at 1800 rpm			4				1.0
20	NH-220	4	100:1	Idle				4			2.0
21	NH-200	4	100:1	50 hp at 1800 rpm				4			2.0
22	NH-220	4	100:1	150 hp at 1800 rpm			2	2			1.5
23	6V-71E	2	100:1	40 hp at 40 mph				2	2		2.5
24	6V-71E	2	100:1	Idle				4			2.0
25	6V-71E	2	100:1	40 hp at 40 mph				1	3		2.8
26	6V-71E	2	100:1	Idle					4		3.0
27	6V-71E	2	100:1	40 hp at 40 mph				2		2	3.0
28	6V-71E	2	100:1	Idle			2	2			1.5

TABLE 1E. VEHICLE ODOR EVALUATION RESULTS--BUREAU OF MINES PANEL

("P" Pungent Standard)

Date: September 10, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"P" Pungent Responses 0	1/2	1	Average
1	6V-71E	2	100:1	40 hp at 20 mph	4			0
2	6V-71E	2	100:1	40 hp at 20 mph	4			0
3	6V-71E	2	100:1	Idle	4			0
4	6V-71E	2	100:1	Idle	4			0
5	6V-71E	2	100:1	40 hp at 20 mph	4			0
6	6V-71E	2	100:1	Idle	4			0
7	6V-71E	2	100:1	Idle	4			0
8	6V-71E	2	100:1	40 hp at 20 mph	4			0
9	6V-71E	2	100:1	Idle	3	1		0.1
10	6V-71E	2	100:1	40 hp at 40 mph	4			0
11	NH-220	4	100:1	50 hp at 1800 rpm	4			0
12	NH-220	4	100:1	150 hp at 1800 rpm	4			0
13	NH-220	4	100:1	Idle	3	1		0.1
14	NH-220	4	100:1	150 hp at 1800 rpm	4			0
15	NH-220	4	100:1	Idle	4			0
16	NH-220	4	100:1	50 hp at 1800 rpm		3	1	0.6
17	NH-220	4	100:1	150 hp at 1800 rpm		Void		--
18	NH-220	4	100:1	Idle	3		1	0.3
19	NH-220	4	100:1	50 hp at 1800 rpm	3	1		0.1
20	NH-220	4	100:1	Idle	4			0
21	NH-220	4	100:1	50 hp at 1800 rpm	1	3		0.1
22	NH-220	4	100:1	150 hp at 1800 rpm	2	2		0.5
23	6V-71E	2	100:1	40 hp at 40 mph	4			0
24	6V-71E	2	100:1	Idle	4			0
25	6V-71E	2	100:1	40 hp at 40 mph	4			0
26	6V-71E	2	100:1	Idle	4			0
27	6V-71E	2	100:1	40 hp at 40 mph	4			0
28	6V-71E	2	100:1	Idle	4			0

TABLE 2A. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("D" Diesel Composite Results)

Date: September 10, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"D" Diesel Composite Responses						
					0	4	5	6	7	8	Average
1	6V-71E	2	100:1	40 hp at 20 mph			2	2			5.5
2	6V-71E	2	100:1	40 hp at 20 mph		2	2				4.5
3	6V-71E	2	100:1	Idle				4			6.0
4	6V-71E	2	100:1	Idle		4					4.0
5	6V-71E	2	100:1	40 hp at 20 mph			4				5.0
6	6V-71E	2	100:1	Idle	4						0
7	6V-71E	2	100:1	Idle				4			6.0
8	6V-71E	2	100:1	40 hp at 20 mph					4		7.0
9	6V-71E	2	100:1	Idle				4			6.0
10	6V-71E	2	100:1	40 hp at 40 mph		1	3				4.8
11	NH-220	4	100:1	50 hp at 1800 rpm			1	3			5.8
12	NH-220	4	100:1	150 hp at 1800 rpm		1	3				4.8
13	NH-220	4	100:1	Idle			1	3			5.8
14	NH-220	4	100:1	150 hp at 1800 rpm			1	3			5.8
15	NH-220	4	100:1	Idle		2	2				4.5
16	NH-220	4	100:1	50 hp at 1800 rpm			3	1			5.3
17	NH-220	4	100:1	150 hp at 1800 rpm				Void			--
18	NH-220	4	100:1	Idle		1	3				5.8
19	NH-220	4	100:1	50 hp at 1800 rpm			2	2			5.5
20	NH-220	4	100:1	Idle			2	2			5.5
21	NH-220	4	100:1	50 hp at 1800 rpm				3	1		6.3
22	NH-220	4	100:1	150 hp at 1800 rpm			2	2			5.5
23	6V-71E	2	100:1	40 hp at 40 mph					2	2	7.5
24	6V-71E	2	100:1	Idle				2	2		6.5
25	6V-71E	2	100:1	40 hp at 40 mph				2	2		6.5
26	6V-71E	2	100:1	Idle		1	1	2			5.3
27	6V-71E	2	100:1	40 hp at 40 mph				1	1	2	7.3
28	6V-71E	2	100:1	Idle			2	2			5.5

TABLE 2B. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("B" Burnt-Smoky Standard)

Date: September 10, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"B" Burnt Responses 0	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph		1	3		1.8
2	6V-71E	2	100:1	40 hp at 20 mph		2	2		1.5
3	6V-71E	2	100:1	Idle			4		2.0
4	6V-71E	2	100:1	Idle		3	1		1.3
5	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
6	6V-71E	2	100:1	Idle	4				0
7	6V-71E	2	100:1	Idle			4		2.0
8	6V-71E	2	100:1	40 hp at 20 mph			3	1	2.3
9	6V-71E	2	100:1	Idle			4		2.0
10	6V-71E	2	100:1	40 hp at 40 mph		1	3		1.8
11	NH-220	4	100:1	50 hp at 1800 rpm			4		2.0
12	NH-220	4	100:1	150 hp at 1800 rpm		1	3		1.8
13	NH-220	4	100:1	Idle		1	3		1.8
14	NH-220	4	100:1	150 hp at 1800 rpm			3	1	2.3
15	NH-220	4	100:1	Idle		1	3		1.8
16	NH-220	4	100:1	50 hp at 1800 rpm		2	2		1.5
17	NH-220	4	100:1	150 hp at 1800 rpm			Void		--
18	NH-220	4	100:1	Idle		1	3		1.8
19	NH-220	4	100:1	50 hp at 1800 rpm			4		2.0
20	NH-220	4	100:1	Idle		1	3		1.8
21	NH-220	4	100:1	50 hp at 1800 rpm			4		2.0
22	NH-220	4	100:1	150 hp at 1800 rpm		1	3		1.8
23	6V-71E	2	100:1	40 hp at 40 mph			2	2	2.5
24	6V-71E	2	100:1	Idle			3	1	2.3
25	6V-71E	2	100:1	40 hp at 40 mph		1	3		1.8
26	6V-71E	2	100:1	Idle		1	3		1.8
27	6V-71E	2	100:1	40 hp at 40 mph			2	2	2.5
28	6V-71E	2	100:1	Idle			4		2.0

TABLE 2C. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("O" Oily Standard)

Date: September 10, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"O" Oily Responses			
					0	1	2	Average
1	6V-71E	2	100:1	40 hp at 20 mph		2	2	1.5
2	6V-71E	2	100:1	40 hp at 20 mph		4		1.0
3	6V-71E	2	100:1	Idle		1	3	1.8
4	6V-71E	2	100:1	Idle		4		1.0
5	6V-71E	2	100:1	40 hp at 20 mph		4		1.0
6	6V-71E	2	100:1	Idle	4			0
7	6V-71E	2	100:1	Idle			4	2.0
8	6V-71E	2	100:1	40 hp at 20 mph			4	2.0
9	6V-71E	2	100:1	Idle			4	2.0
10	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
11	NH-220	4	100:1	50 hp at 1800 rpm		1	3	1.8
12	NH-220	4	100:1	150 hp at 1800 rpm		3	1	1.3
13	NH-220	4	100:1	Idle		2	2	1.5
14	NH-220	4	100:1	150 hp at 1800 rpm		4		1.0
15	NH-220	4	100:1	Idle		4		1.0
16	NH-220	4	100:1	50 hp at 1800 rpm		4		1.0
17	NH-220	4	100:1	150 hp at 1800 rpm		Void		--
18	NH-220	4	100:1	Idle	1	3		0.8
19	NH-220	4	100:1	50 hp at 1800 rpm		1	3	1.8
20	NH-220	4	100:1	Idle		3	1	1.3
21	NH-220	4	100:1	50 hp at 1800 rpm		2	2	1.5
22	NH-220	4	100:1	150 hp at 1800 rpm		2	2	1.5
23	6V-71E	2	100:1	40 hp at 40 mph			4	2.0
24	6V-71E	2	100:1	Idle		1	3	1.8
25	6V-71E	2	100:1	40 hp at 40 mph		1	3	1.8
26	6V-71E	2	100:1	Idle		1	3	1.8
27	6V-71E	2	100:1	40 hp at 40 mph			4	2.0
28	6V-71E	2	100:1	Idle		1	3	1.8

TABLE 2D. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("A" Aromatic Standard)

Date: September 10, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"A" Aromatic Responses 0	1	2	Average
1	6V-71E	2	100:1	40 hp at 20 mph		4		1.0
2	6V-71E	2	100:1	40 hp at 20 mph		4		1.0
3	6V-71E	2	100:1	Idle		2	2	1.5
4	6V-71E	2	100:1	Idle		4		1.0
5	6V-71E	2	100:1	40 hp at 20 mph	1	3		0.8
6	6V-71E	2	100:1	Idle	4			0
7	6V-71E	2	100:1	Idle		3	1	1.3
8	6V-71E	2	100:1	40 hp at 20 mph		2	2	1.5
9	6V-71E	2	100:1	Idle		3	1	1.3
10	6V-71E	2	100:1	40 hp at 40 mph	2	2		0.5
11	NH-220	4	100:1	50 hp at 1800 rpm	2	2		0.5
12	NH-220	4	100:1	150 hp at 1800 rpm	1	3		0.8
13	NH-220	4	100:1	Idle		2	2	1.5
14	NH-220	4	100:1	150 hp at 1800 rpm		1	3	1.8
15	NH-220	4	100:1	Idle		3	1	1.3
16	NH-220	4	100:1	50 hp at 1800 rpm			4	2.0
17	NH-220	4	100:1	150 hp at 1800 rpm		Void		--
18	NH-220	4	100:1	Idle		2	2	1.5
19	NH-220	4	100:1	50 hp at 1800 rpm		3	1	1.3
20	NH-220	4	100:1	Idle		2	2	1.5
21	NH-220	4	100:1	50 hp at 1800 rpm			4	2.0
22	NH-220	4	100:1	150 hp at 1800 rpm	1	2	1	1.0
23	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
24	6V-71E	2	100:1	Idle		2	2	1.5
25	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
26	6V-71E	2	100:1	Idle		2	2	1.5
27	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
28	6V-71E	2	100:1	Idle		3	1	1.3

TABLE 2E. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("P" Pungent Standard)

Date: September 10, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"P" Pungent Responses 0	1	2	Average
1	6V-71E	2	100:1	40 hp at 20 mph	1	3		0.8
2	6V-71E	2	100:1	40 hp at 20 mph	3	1		0.3
3	6V-71E	2	100:1	Idle	3	1		0.3
4	6V-71E	2	100:1	Idle	4			0
5	6V-71E	2	100:1	40 hp at 20 mph	2	2		0.5
6	6V-71E	2	100:1	Idle	4			0
7	6V-71E	2	100:1	Idle	1	3		0.8
8	6V-71E	2	100:1	40 hp at 20 mph		4		1.0
9	6V-71E	2	100:1	Idle	2	2		0.5
10	6V-71E	2	100:1	40 hp at 40 mph	2	2		0.5
11	NH-220	4	100:1	50 hp at 1800 rpm		4		1.0
12	NH-220	4	100:1	150 hp at 1800 rpm	4			0
13	NH-220	4	100:1	Idle	3	1		0.3
14	NH-220	4	100:1	150 hp at 1800 rpm	3	1		0.3
15	NH-220	4	100:1	Idle	3	1		0.3
16	NH-220	4	100:1	50 hp at 1800 rpm	4			0
17	NH-220	4	100:1	150 hp at 1800 rpm				
18	NH-220	4	100:1	Idle	3	1		0.3
19	NH-220	4	100:1	50 hp at 1800 rpm	2	2		0.5
20	NH-220	4	100:1	Idle	3	1		0.3
21	NH-220	4	100:1	50 hp at 1800 rpm	2	2		0.5
22	NH-220	4	100:1	150 hp at 1800 rpm	3	1		0.3
23	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
24	6V-71E	2	100:1	Idle	1	2	1	1.0
25	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
26	6V-71E	2	100:1	Idle	4			0
27	6V-71E	2	100:1	40 hp at 40 mph		3	1	1.3
28	6V-71E	2	100:1	Idle	2	2		0.5

TABLE 3A. VEHICLE ODOR EVALUATION RESULTS--BUREAU OF MINES PANEL

("D" Diesel Composite Results)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"D" Diesel Composite Responses								
					2-1/2	3	4	5	6	7	8	9	Average
1	6V-71E	2	100:1	40 hp at 20 mph		1	2	1					4.0
2	6V-71E	2	100:1	40 hp at 40 mph			3	1					4.3
3	6V-71E	2	100:1	Idle		1	3						3.8
4	6V-71E	2	100:1	40 hp at 40 mph		1	2		1				4.3
5	6V-71E	2	100:1	40 hp at 20 mph				4					5.0
6	6V-71E	2	100:1	40 hp at 20 mph				1	3				5.8
7	6V-71E	2	100:1	Idle			3	1					4.3
8	6V-71E	2	100:1	40 hp at 40 mph			1	3					4.8
9	6V-71E	2	100:1	Idle					1	3			6.8
10	6V-71E	2	300:1	40 hp at 20 mph			4						4.0
11	6V-71E	2	300:1	40 hp at 40 mph		2	2						3.5
12	6V-71E	2	300:1	Idle		4							3.0
13	6V-71E	2	300:1	40 hp at 40 mph		3	1						3.3
14	6V-71E	2	300:1	40 hp at 20 mph		3	1						3.3
15	6V-71E	2	300:1	40 hp at 20 mph		4							3.0
16	6V-71E	2	300:1	Idle	1	2	1						3.1
17	6V-71E	2	300:1	40 hp at 40 mph			4						4.0
18	6V-71E	2	300:1	Idle		3	1						3.3
19	6V-71E	2	100:1	Idle-Acceleration					2	2			6.5
20	6V-71E	2	100:1	40 hp at 20 mph						2	2		7.5
21	6V-71E	2	100:1	Idle-Acceleration					1		3		7.5
22	6V-71E	2	100:1	Deceleration							1	3	8.8
23	6V-71E	2	100:1	40 hp at 20 mph					4				6.0
24	6V-71E	2	100:1	Deceleration					4				6.0
25	6V-71E	2	100:1	Idle-Acceleration							4		8.0
26	6V-71E	2	100:1	Deceleration						2		2	8.0
27	6V-71E	2	100:1	40 hp at 20 mph						2	2		7.5
28	6V-71E	2	100:1	Deceleration						2	2		7.5
29	6V-71E	2	100:1	40 hp at 20 mph						4			7.0
30	6V-71E	2	100:1	Idle-Acceleration							4		8.0

TABLE 3B. VEHICLE ODOR EVALUATION RESULTS--BUREAU OF MINES PANEL

("B" Burnt-Smoky Standard)

Date: September 11, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"B" Burnt-Smoky Responses						
					0	1/2	1	2	3	4	Average
1	6V-71E	2	100:1	40 hp at 20 mph			1	3			1.8
2	6V-71E	2	100:1	40 hp at 40 mph			4				1.0
3	6V-71E	2	100:1	Idle	3		1				0.3
4	6V-71E	2	100:1	40 hp at 40 mph			3	1			1.3
5	6V-71E	2	100:1	40 hp at 20 mph				4			2.0
6	6V-71E	2	100:1	40 hp at 20 mph			2	2			1.5
7	6V-71E	2	100:1	Idle			1	3			1.8
8	6V-71E	2	100:1	40 hp at 40 mph		1	3				0.9
9	6V-71E	2	100:1	Idle					4		3.0
10	6V-71E	2	300:1	40 hp at 20 mph			4				1.0
11	6V-71E	2	300:1	40 hp at 40 mph	1	1	2				0.6
12	6V-71E	2	300:1	Idle	2	1	1				0.4
13	6V-71E	2	300:1	40 hp at 40 mph	2	1	1				0.4
14	6V-71E	2	300:1	40 hp at 20 mph			3	1			1.3
15	6V-71E	2	300:1	40 hp at 20 mph		1	3				0.9
16	6V-71E	2	300:1	Idle	2	1	1				0.4
17	6V-71E	2	300:1	40 hp at 40 mph			2	2			1.5
18	6V-71E	2	300:1	Idle	3	1					0.1
19	6V-71E	2	100:1	Idle-Acceleration				2	2		2.5
20	6V-71E	2	100:1	40 hp at 20 mph					2	2	3.5
21	6V-71E	2	100:1	Idle-Acceleration				1	3		1.8
22	6V-71E	2	100:1	Deceleration				1	3		1.8
23	6V-71E	2	100:1	40 hp at 20 mph					4		3.0
24	6V-71E	2	100:1	Deceleration			3	1			1.3
25	6V-71E	2	100:1	Idle-Acceleration					4		3.0
26	6V-71E	2	100:1	Deceleration				2	2		2.5
27	6V-71E	2	100:1	40 hp at 20 mph					4		3.0
28	6V-71E	2	100:1	Deceleration				2	2		2.5
29	6V-71E	2	100:1	40 hp at 20 mph					4		3.0
30	6V-71E	2	100:1	Idle-Acceleration					4		3.0

TABLE 3C. VEHICLE ODOR EVALUATION RESULTS-- BUREAU OF MINES PANEL

("O" Oily Standard)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"O" Oily Responses 0	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph		2	2		1.5
2	6V-71E	2	100:1	40 hp at 40 mph		3	1		1.3
3	6V-71E	2	100:1	Idle		1	3		1.8
4	6V-71E	2	100:1	40 hp at 40 mph		3	1		1.3
5	6V-71E	2	100:1	40 hp at 20 mph		3	1		1.3
6	6V-71E	2	100:1	40 hp at 20 mph		1	3		1.8
7	6V-71E	2	100:1	Idle	1	1	2		1.3
8	6V-71E	2	100:1	40 hp at 40 mph		1	3		1.8
9	6V-71E	2	100:1	Idle		1	3		1.8
10	6V-71E	2	300:1	40 hp at 20 mph		4			1.0
11	6V-71E	2	300:1	40 hp at 40 mph		3	1		1.3
12	6V-71E	2	300:1	Idle	1	3			0.8
13	6V-71E	2	300:1	40 hp at 40 mph		3	1		1.3
14	6V-71E	2	300:1	40 hp at 20 mph		4			1.0
15	6V-71E	2	300:1	40 hp at 20 mph		3	1		1.3
16	6V-71E	2	300:1	Idle		2	2		1.5
17	6V-71E	2	300:1	40 hp at 40 mph		3	1		1.3
18	6V-71E	2	300:1	Idle		3	1		1.3
19	6V-71E	2	100:1	Idle-Acceleration			1	3	2.8
20	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
21	6V-71E	2	100:1	Idle-Acceleration			3	1	2.3
22	6V-71E	2	100:1	Deceleration			1	3	2.8
23	6V-71E	2	100:1	40 hp at 20 mph		3	1		1.3
24	6V-71E	2	100:1	Deceleration		1	3		1.8
25	6V-71E	2	100:1	Idle-Acceleration				4	3.0
26	6V-71E	2	100:1	Deceleration			2	2	2.5
27	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
28	6V-71E	2	100:1	Deceleration			4		2.0
29	6V-71E	2	100:1	40 hp at 20 mph			3	1	2.3
30	6V-71E	2	100:1	Idle-Acceleration			3	1	2.3

TABLE 3D. VEHICLE ODOR EVALUATION RESULTS-- BUREAU OF MINES PANEL

("A" Aromatic Standard)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"A" Aromatic Responses 0	1	2	3	4	Average
1	6V-71E	2	100:1	40 hp at 20 mph	1	3				0.8
2	6V-71E	2	100:1	40 hp at 40 mph			4			2.0
3	6V-71E	2	100:1	Idle		1	3			1.8
4	6V-71E	2	100:1	40 hp at 40 mph		1	3			1.8
5	6V-71E	2	100:1	40 hp at 20 mph		1	3			1.8
6	6V-71E	2	100:1	40 hp at 20 mph			2	2		2.5
7	6V-71E	2	100:1	Idle		1	3			1.8
8	6V-71E	2	100:1	40 hp at 40 mph			3	1		2.3
9	6V-71E	2	100:1	Idle			3	1		2.3
10	6V-71E	2	300:1	40 hp at 20 mph			4			2.0
11	6V-71E	2	300:1	40 hp at 40 mph		2	1	1		1.8
12	6V-71E	2	300:1	Idle			4			2.0
13	6V-71E	2	300:1	40 hp at 40 mph		1	3			1.8
14	6V-71E	2	300:1	40 hp at 20 mph		4				1.0
15	6V-71E	2	300:1	40 hp at 20 mph		4				1.0
16	6V-71E	2	300:1	Idle		3	1			1.3
17	6V-71E	2	300:1	40 hp at 40 mph	1	1	2			1.3
18	6V-71E	2	300:1	Idle			4			2.0
19	6V-71E	2	100:1	Idle-Acceleration		1	3			1.8
20	6V-71E	2	100:1	40 hp at 20 mph			4			2.0
21	6V-71E	2	100:1	Idle-Acceleration			2	2		2.5
22	6V-71E	2	100:1	Deceleration				2	2	3.5
23	6V-71E	2	100:1	40 hp at 20 mph		1	3			1.8
24	6V-71E	2	100:1	Deceleration				4		3.0
25	6V-71E	2	100:1	Idle-Acceleration			4			2.0
26	6V-71E	2	100:1	Deceleration				4		3.0
27	6V-71E	2	100:1	40 hp at 20 mph			3	1		2.3
28	6V-71E	2	100:1	Deceleration			2		2	3.0
29	6V-71E	2	100:1	40 hp at 20 mph		1	3			1.8
30	6V-71E	2	100:1	Idle-Acceleration			1	3		2.8

TABLE 3E. VEHICLE ODOR EVALUATION RESULTS--BUREAU OF MINES PANEL

("P" Pungent Standard)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"P" Pungent Responses		
					0	1/2	Average
1	6V-71E	2	100:1	40 hp at 20 mph	4		0
2	6V-71E	2	100:1	40 hp at 40 mph	4		0
3	6V-71E	2	100:1	Idle	4		0
4	6V-71E	2	100:1	40 hp at 40 mph	4		0
5	6V-71E	2	100:1	40 hp at 20 mph	4		0
6	6V-71E	2	100:1	40 hp at 20 mph	4		0
7	6V-71E	2	100:1	Idle	4		0
8	6V-71E	2	100:1	40 hp at 40 mph	3	1	0.1
9	6V-71E	2	100:1	Idle	4		0
10	6V-71E	2	300:1	40 hp at 20 mph	4		0
11	6V-71E	2	300:1	40 hp at 40 mph	4		0
12	6V-71E	2	300:1	Idle	4		0
13	6V-71E	2	300:1	40 hp at 40 mph	4		0
14	6V-71E	2	300:1	40 hp at 20 mph	4		0
15	6V-71E	2	300:1	40 hp at 20 mph	4		0
16	6V-71E	2	300:1	Idle	4		0
17	6V-71E	2	300:1	40 hp at 40 mph	4		0
18	6V-71E	2	300:1	Idle	4		0
19	6V-71E	2	100:1	Idle-Acceleration	4		0
20	6V-71E	2	100:1	40 hp at 20 mph	4		0
21	6V-71E	2	100:1	Idle-Acceleration	4		0
22	6V-71E	2	100:1	Deceleration	4		0
23	6V-71E	2	100:1	40 hp at 20 mph	4		0
24	6V-71E	2	100:1	Deceleration	4		0
25	6V-71E	2	100:1	Idle-Acceleration	3	1	0.1
26	6V-71E	2	100:1	Deceleration	4		0
27	6V-71E	2	100:1	40 hp at 20 mph	4		0
28	6V-71E	2	100:1	Deceleration	4		0
29	6V-71E	2	100:1	40 hp at 20 mph	4		0
30	6V-71E	2	100:1	Idle-Acceleration	4		0

TABLE 4A. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("D" Diesel Composite Results)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"D" Diesel Composite Responses 2	3	4	5	6	7	8	9	Average
1	6V-71E	2	100:1	40 hp at 20 mph				2	2				5.5
2	6V-71E	2	100:1	40 hp at 40 mph			2	2					4.5
3	6V-71E	2	100:1	Idle			3	1					4.3
4	6V-71E	2	100:1	40 hp at 40 mph		2	1	1					3.8
5	6V-71E	2	100:1	40 hp at 20 mph				2	2				5.5
6	6V-71E	2	100:1	40 hp at 20 mph				3	1				5.3
7	6V-71E	2	100:1	Idle				1	3				5.8
8	6V-71E	2	100:1	40 hp at 40 mph				1	3				5.8
9	6V-71E	2	100:1	Idle				1	3				5.8
10	6V-71E	2	300:1	40 hp at 20 mph				4					5.0
11	6V-71E	2	300:1	40 hp at 40 mph	2	2							2.5
12	6V-71E	2	300:1	Idle			3	1					4.3
13	6V-71E	2	300:1	40 hp at 40 mph	1		1	2					4.0
14	6V-71E	2	300:1	40 hp at 20 mph			2	2					4.5
15	6V-71E	2	300:1	40 hp at 20 mph			4						4.0
16	6V-71E	2	300:1	Idle		2	2						3.5
17	6V-71E	2	300:1	40 hp at 40 mph			4						4.0
18	6V-71E	2	300:1	Idle			2	2					4.5
19	6V-71E	2	100:1	Idle-Acceleration						4			7.0
20	6V-71E	2	100:1	40 hp at 20 mph						1	3		7.8
21	6V-71E	2	100:1	Idle-Acceleration						4			7.0
22	6V-71E	2	100:1	Deceleration							3	1	8.3
23	6V-71E	2	100:1	40 hp at 20 mph						3	1		7.3
24	6V-71E	2	100:1	Deceleration						2	2		7.5
25	6V-71E	2	100:1	Idle-Acceleration					1	3			6.8
26	6V-71E	2	100:1	Deceleration						1	3		7.8
27	6V-71E	2	100:1	40 hp at 20 mph						2	2		7.5
28	6V-71E	2	100:1	Deceleration						1	3		7.8
29	6V-71E	2	100:1	40 hp at 20 mph						3	1		7.3
30	6V-71E	2	100:1	Idle-Acceleration						4			7.0

TABLE 4B. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("B" Burnt-Smoky Standard)

Date: September 11, 1968 Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"B" Burnt Responses				
					0	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
2	6V-71E	2	100:1	40 hp at 40 mph		2	2		1.5
3	6V-71E	2	100:1	Idle		2	2		1.5
4	6V-71E	2	100:1	40 hp at 40 mph		3	1		1.3
5	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
6	6V-71E	2	100:1	40 hp at 20 mph		1	3		1.8
7	6V-71E	2	100:1	Idle			4		2.0
8	6V-71E	2	100:1	40 hp at 40 mph			4		2.0
9	6V-71E	2	100:1	Idle			4		2.0
10	6V-71E	2	300:1	40 hp at 20 mph			4		2.0
11	6V-71E	2	300:1	40 hp at 40 mph	2	2			0.5
12	6V-71E	2	300:1	Idle		2	2		1.5
13	6V-71E	2	300:1	40 hp at 40 mph	1	3			0.8
14	6V-71E	2	300:1	40 hp at 20 mph		2	2		1.5
15	6V-71E	2	300:1	40 hp at 20 mph		3	1		1.3
16	6V-71E	2	300:1	Idle		3	1		1.3
17	6V-71E	2	300:1	40 hp at 40 mph		3	1		1.3
18	6V-71E	2	300:1	Idle		4			1.0
19	6V-71E	2	100:1	Idle-Acceleration			3	1	2.3
20	6V-71E	2	100:1	40 hp at 20 mph			1	3	2.8
21	6V-71E	2	100:1	Idle-Acceleration			3	1	2.3
22	6V-71E	2	100:1	Deceleration				4	3.0
23	6V-71E	2	100:1	40 hp at 20 mph			2	2	2.5
24	6V-71E	2	100:1	Deceleration			2	2	2.5
25	6V-71E	2	100:1	Idle-Acceleration			3	1	2.3
26	6V-71E	2	100:1	Deceleration			1	3	2.8
27	6V-71E	2	100:1	40 hp at 20 mph			3	1	2.3
28	6V-71E	2	100:1	Deceleration			2	2	2.5
29	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
30	6V-71E	2	100:1	Idle-Acceleration			3	1	2.3

TABLE 4C. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("O" Oily Standard)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"O" Oily Responses 0	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph		2	2		1.5
2	6V-71E	2	100:1	40 hp at 40 mph		3	1		1.3
3	6V-71E	2	100:1	Idle	1	3			0.8
4	6V-71E	2	100:1	40 hp at 40 mph	1	3			0.8
5	6V-71E	2	100:1	40 hp at 20 mph		1	3		1.8
6	6V-71E	2	100:1	40 hp at 20 mph		3	1		1.3
7	6V-71E	2	100:1	Idle		1	3		1.8
8	6V-71E	2	100:1	40 hp at 40 mph		1	3		1.8
9	6V-71E	2	100:1	Idle		1	3		1.8
10	6V-71E	2	300:1	40 hp at 20 mph		3	1		1.3
11	6V-71E	2	300:1	40 hp at 40 mph		4			1.0
12	6V-71E	2	300:1	Idle		3	1		1.3
13	6V-71E	2	300:1	40 hp at 40 mph		3	1		1.3
14	6V-71E	2	300:1	40 hp at 20 mph		3	1		1.3
15	6V-71E	2	300:1	40 hp at 20 mph		4			1.0
16	6V-71E	2	300:1	Idle	1	2	1		1.0
17	6V-71E	2	300:1	40 hp at 40 mph	1	3			0.8
18	6V-71E	2	300:1	Idle		4			1.0
19	6V-71E	2	100:1	Idle-Acceleration			4		2.0
20	6V-71E	2	100:1	40 hp at 20 mph			3	1	2.3
21	6V-71E	2	100:1	Idle-Acceleration			4		2.0
22	6V-71E	2	100:1	Deceleration			3	1	2.3
23	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
24	6V-71E	2	100:1	Deceleration			4		2.0
25	6V-71E	2	100:1	Idle-Acceleration			4		2.0
26	6V-71E	2	100:1	Deceleration			4		2.0
27	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
28	6V-71E	2	100:1	Deceleration		1	3		1.8
29	6V-71E	2	100:1	40 hp at 20 mph			4		2.0
30	6V-71E	2	100:1	Idle-Acceleration			4		2.0

TABLE 4D VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("A" Aromatic Standard)

Date: September 11, 1968

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"A" Aromatic Responses				
					0	1	2	3	Average
1	6V-71E	2	100:1	40 hp at 20 mph		4			1.0
2	6V-71E	2	100:1	40 hp at 40 mph	1	3			0.8
3	6V-71E	2	100:1	Idle		4			1.0
4	6V-71E	2	100:1	40 hp at 40 mph	1	3			0.8
5	6V-71E	2	100:1	40 hp at 20 mph	1	3			0.8
6	6V 71E	2	100:1	40 hp at 20 mph		4			1.0
7	6V-71E	2	100:1	Idle		4			1.0
8	6V-71E	2	100:1	40 hp at 40 mph	1	3			0.8
9	6V-71E	2	100:1	Idle	2		2		1.0
10	6V-71E	2	300:1	40 hp at 20 mph	2	2			0.5
11	6V-71E	2	300:1	40 hp at 40 mph	1	3			0.8
12	6V-71E	2	300:1	Idle	2	3			0.5
13	6V-71E	2	300:1	40 hp at 40 mph		4			1.0
14	6V-71E	2	300:1	40 hp at 20 mph	2	2			0.5
15	6V-71E	2	300:1	40 hp at 20 mph		4			1.0
16	6V-71E	2	300:1	Idle		4			1.0
17	6V-71E	2	300:1	40 hp at 40 mph		4			1.0
18	6V-71E	2	300:1	Idle		4			1.0
19	6V-71E	2	100:1	Idle-Acceleration		3	1		1.3
20	6V-71E	2	100:1	40 hp at 20 mph	1	2	1		1.0
21	6V-71E	2	100:1	Idle-Acceleration		3	1		1.3
22	6V-71E	2	100:1	Deceleration			3	1	2.3
23	6V-71E	2	100:1	40 hp at 20 mph		2	2		1.5
24	6V-71E	2	100:1	Deceleration			4		2.0
25	6V-71E	2	100:1	Idle-Acceleration		2	2		1.5
26	6V-71E	2	100:1	Deceleration			4		2.0
27	6V-71E	2	100:1	40 hp at 20 mph		2	2		1.5
28	6V-71E	2	100:1	Deceleration			3	1	2.3
29	6V-71E	2	100:1	40 hp at 20 mph		1	3		1.8
30	6V-71E	2	100:1	Idle-Acceleration		2	2		1.5

TABLE 4E. VEHICLE ODOR EVALUATION RESULTS--SwRI PANEL

("P" Pungent Standard)

Date: September 11, 1968 | Fuel: EM-70-F (No. 1 Diesel)

Run No.	Engine	No. of Cycles	Dilution Ratio	Operating Conditions	"P" Pungent Responses			
					0	1	2	Average
1	6V-71E	2	100:1	40 hp at 20 mph	1	3		0.8
2	6V-71E	2	100:1	40 hp at 40 mph	4			0
3	6V-71E	2	100:1	Idle	4			0
4	6V-71E	2	100:1	40 hp at 40 mph	4			0
5	6V-71E	2	100:1	40 hp at 20 mph	1	3		0.8
6	6V-71E	2	100:1	40 hp at 20 mph	2	2		0.5
7	6V-71E	2	100:1	Idle	2	2		0.5
8	6V-71E	2	100:1	40 hp at 40 mph		4		1.0
9	6V-71E	2	100:1	Idle	1	2	1	1.0
10	6V-71E	2	300:1	40 hp at 20 mph	2	2		0.5
11	6V-71E	2	300:1	40 hp at 40 mph	4			0
12	6V-71E	2	300:1	Idle	3	1		0.3
13	6V-71E	2	300:1	40 hp at 40 mph	3	1		0.3
14	6V-71E	2	300:1	40 hp at 20 mph	3	1		0.3
15	6V-71E	2	300:1	40 hp at 20 mph	4			0
16	6V-71E	2	300:1	Idle	3	1		0.3
17	6V-71E	2	300:1	40 hp at 40 mph	4			0
18	6V-71E	2	300:1	Idle	2	2		0.5
19	6V-71E	2	100:1	Idle-Acceleration		1	3	1.8
20	6V-71E	2	100:1	40 hp at 20 mph			4	2.0
21	6V-71E	2	100:1	Idle-Acceleration			4	2.0
22	6V-71E	2	100:1	Deceleration		3	1	1.3
23	6V-71E	2	100:1	40 hp at 20 mph		2	2	1.5
24	6V-71E	2	100:1	Deceleration		2	2	1.5
25	6V-71E	2	100:1	Idle-Acceleration		4		1.0
26	6V-71E	2	100:1	Deceleration		3	1	1.3
27	6V-71E	2	100:1	40 hp at 20 mph		2	2	1.5
28	6V-71E	2	100:1	Deceleration		3	1	1.3
29	6V-71E	2	100:1	40 hp at 20 mph		2	2	1.5
30	6V-71E	2	100:1	Idle-Acceleration		2	2	1.5

EFFECT OF FUEL TYPE ON EXHAUST ODOR

2-CYCLE POWERED MUNICIPAL BUS

Preceding page blank

TABLE 5. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 687
Date: October 23, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-29-F (No. 2 Diesel)

		Average Panel Responses				
Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	6.4	2.1	1.9	1.5	1.0
8	" "	6.6	2.0	1.9	1.5	1.3
14	" "	7.3	2.4	2.2	1.5	1.5
22	" "	7.1	2.5	2.0	1.6	1.3
		6.9	2.3	2.0	1.5	1.3
3	30 mph at 40 hp	5.7	1.7	1.5	1.2	1.0
9	" "	6.8	2.1	1.9	1.5	1.3
12	" "	6.8	2.0	1.8	1.6	1.2
16	" "	6.4	2.1	1.8	1.9	1.0
		6.4	2.0	1.8	1.6	1.1
1	40 mph at 40 hp	5.8	2.0	2.0	1.1	1.0
7	" "	6.4	2.0	1.8	1.5	1.0
10	" "	6.7	1.9	1.8	1.5	1.0
24	" "	6.1	2.0	1.8	1.5	1.1
		6.3	2.0	1.9	1.4	1.0
4	Idle	5.5	1.9	1.7	1.3	1.0
11	"	6.0	2.0	1.8	1.3	1.0
18	"	6.1	2.0	1.9	1.6	1.0
23	"	5.9	1.5	1.5	1.3	1.0
		5.9	1.9	1.7	1.4	1.0
6	Idle-Acceleration	7.5	2.5	2.1	1.8	1.3
13	" "	7.5	2.3	2.1	1.6	1.5
17	" "	7.4	2.5	2.0	1.8	1.0
21	" "	7.6	2.5	2.2	1.9	1.3
		7.5	2.5	2.1	1.8	1.3
5	Deceleration	6.8	2.2	2.0	1.8	1.1
15	"	7.4	2.5	2.2	1.6	1.2
19	"	7.5	2.5	2.0	1.6	1.2
20	"	7.5	2.2	2.0	1.2	1.0
		7.3	2.4	2.1	1.6	1.1

TABLE 5A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Results)

Vehicle: Bus 687
Date: October 23, 1968

Operating Conditions: See Tables 2 through 5, Appendix A

Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses				
		5	6	7	8	Average
1	40 mph at 40 hp	2	8			5.8
2	20 mph at 40 hp		6	4		6.4
3	30 mph at 40 hp	3	7			5.7
4	Idle	5	5			5.5
5	Deceleration		3	6	1	6.8
6	Idle-Acceleration			5	5	7.5
7	40 mph at 40 hp	2	2	6		6.4
8	20 mph at 40 hp	1	2	7		6.6
9	30 mph at 40 hp		2	8		6.8
10	40 mph at 40 hp	1	1	8		6.7
11	Idle	1	8	1		6.0
12	30 mph at 40 hp		4	4	2	6.8
13	Idle-Acceleration			5	5	7.5
14	20 mph at 40 hp			7	3	7.3
15	Deceleration		2	2	6	7.4
16	30 mph at 40 hp	2	3	4	1	6.4
17	Idle-Acceleration			6	4	7.4
18	Idle	1	7	2		6.1
19	Deceleration		1	3	6	7.5
20	Deceleration			5	5	7.5
21	Idle-Acceleration		1	2	7	7.6
22	20 mph at 40 hp		2	5	3	7.1
23	Idle	3	5	2		5.9
24	40 mph at 40 hp	1	7	2		6.1

TABLE 5B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 687
Date: October 23, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Average
1	40 mph at 40 hp		10		2.0
2	20 mph at 40 hp		9	1	2.1
3	30 mph at 40 hp	3	7		1.7
4	Idle	2	7	1	1.9
5	Deceleration		8	2	2.2
6	Idle-Acceleration		5	5	2.5
7	40 mph at 40 hp	1	8	1	2.0
8	20 mph at 40 hp	1	8	1	2.0
9	30 mph at 40 hp		9	1	2.1
10	40 mph at 40 hp	1	9		1.9
11	Idle	1	8	1	2.0
12	30 mph at 40 hp	2	6	2	2.0
13	Idle-Acceleration		7	3	2.3
14	20 mph at 40 hp		6	4	2.4
15	Deceleration		6	4	2.4
16	30 mph at 40 hp		9	1	2.1
17	Idle-Acceleration		5	5	2.5
18	Idle	1	8	1	2.0
19	Deceleration		5	5	2.5
20	Deceleration		8	2	2.2
21	Idle-Acceleration		5	5	2.5
22	20 mph at 40 hp		5	5	2.5
23	Idle	5	5		1.5
24	40 mph at 40 hp	1	8	1	2.0

TABLE 5C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 687
Date: October 23, 1968

Operating Conditions: See Tables 2 through 5, Appendix A

Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Average
1	40 mph at 40 hp		10		2.0
2	20 mph at 40 hp	1	9		1.9
3	30 mph at 40 hp	5	5		1.5
4	Idle	3	7		1.7
5	Deceleration	1	8	1	2.0
6	Idle-Acceleration	1	7	2	2.1
7	40 mph at 40 hp	2	8		1.8
8	20 mph at 40 hp	1	9		1.9
9	30 mph at 40 hp	2	7	1	1.9
10	40 mph at 40 hp	2	8		1.8
11	Idle	2	8		1.8
12	30 mph at 40 hp	2	8		1.8
13	Idle-Acceleration		9	1	2.1
14	20 mph at 40 hp		8	2	2.2
15	Deceleration		8	2	2.2
16	30 mph at 40 hp	3	6	1	1.8
17	Idle-Acceleration	1	8	1	2.0
18	Idle	2	7	1	1.9
19	Deceleration	1	8	1	2.0
20	Deceleration		10		2.0
21	Idle-Acceleration		8	2	2.2
22	20 mph at 40 hp	2	6	2	2.0
23	Idle	5	5		1.5
24	40 mph at 40 hp	3	6	1	1.8

TABLE 5D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 687
Date: October 23, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses 1	2	3	Average
1	40 mph at 40 hp	9	1		1.1
2	20 mph at 40 hp	5	5		1.5
3	30 mph at 40 hp	8	2		1.2
4	Idle	7	3		1.3
5	Deceleration	2	8		1.8
6	Idle-Acceleration	2	8		1.8
7	40 mph at 40 hp	5	5		1.5
8	20 mph at 40 hp	5	5		1.5
9	30 mph at 40 hp	6	3	1	1.5
10	40 mph at 40 hp	5	5		1.5
11	Idle	7	3		1.3
12	30 mph at 40 hp	5	4	1	1.6
13	Idle-Acceleration	5	4	1	1.6
14	20 mph at 40 hp	5	5		1.5
15	Deceleration	5	4	1	1.6
16	30 mph at 40 hp	2	7	1	1.9
17	Idle-Acceleration	3	6	1	1.8
18	Idle	5	4	1	1.6
19	Deceleration	5	4	1	1.6
20	Deceleration	8	2		1.2
21	Idle-Acceleration	1	9		1.9
22	20 mph at 40 hp	4	6		1.6
23	Idle	7	3		1.3
24	40 mph at 40 hp	5	5		1.5

TABLE 5E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 687
Date: October 23, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 1	2	Average
1	40 mph at 40 hp	10		1.0
2	20 mph at 40 hp	10		1.0
3	30 mph at 40 hp	10		1.0
4	Idle	10		1.0
5	Deceleration	9	1	1.1
6	Idle-Acceleration	7	3	1.3
7	40 mph at 40 hp	10		1.0
8	20 mph at 40 hp	7	3	1.3
9	30 mph at 40 hp	7	3	1.3
10	40 mph at 40 hp	8	1	1.0
11	Idle	10		1.0
12	30 mph at 40 hp	8	2	1.2
13	Idle-Acceleration	5	5	1.5
14	20 mph at 40 hp	5	5	1.5
15	Deceleration	8	2	1.2
16	30 mph at 40 hp	10		1.0
17	Idle-Acceleration	10		1.0
18	Idle	10		1.0
19	Deceleration	8	2	1.2
20	Deceleration	10		1.0
21	Idle-Acceleration	7	3	1.3
22	20 mph at 40 hp	7	3	1.3
23	Idle	10		1.0
24	40 mph at 40 hp	9	1	1.1

TABLE 6. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: Bus 687
Date: October 24, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
6	20 mph at 40 hp	5.1	1.7	1.3	1.1	1.0
8	" "	4.5	1.7	1.3	1.2	1.0
12	" "	5.9	2.0	1.7	1.2	1.0
20	" "	6.1	2.2	1.9	1.3	1.1
		5.4	1.9	1.6	1.2	1.0
3	30 mph at 40 hp	4.5	1.7	1.4	1.3	1.1
7	" "	5.4	1.8	1.3	1.1	1.0
11	" "	6.0	2.0	1.9	1.3	1.2
14	" "	6.9	1.9	1.9	1.3	0.9
		5.7	1.6	1.6	1.3	1.1
2	40 mph at 40 hp	4.5	1.6	1.3	1.1	1.1
17	" "	6.2	2.1	1.8	1.2	0.9
19	" "	6.2	2.0	1.8	1.3	1.1
23	" "	5.9	2.0	1.8	1.3	1.0
		5.7	1.9	1.7	1.2	1.0
5	Idle	6.4	2.0	1.5	1.3	1.6
13	"	5.8	1.9	1.7	1.4	0.8
18	"	5.5	1.8	1.6	1.3	1.0
22	"	6.2	2.0	1.9	1.8	1.1
		6.0	1.9	1.7	1.5	1.1
4	Idle-Acceleration	6.5	2.0	2.0	1.3	1.6
10	" "	6.7	2.1	2.1	1.5	1.4
15	" "	6.9	2.2	2.0	1.4	1.2
24	" "	6.5	1.9	2.0	1.4	1.3
		6.7	2.1	2.0	1.4	1.4
1	Deceleration	5.8	1.8	1.7	1.2	1.1
9	"	6.3	2.1	2.0	1.5	1.4
16	"	6.8	2.2	2.1	1.4	1.3
21	"	7.0	2.3	2.1	1.5	1.3
		6.5	2.1	2.0	1.4	1.3

TABLE 6A. VEHICLE ODOR EVALUATION RESULTS

("D" Diesel Composite Results)

Vehicle: Bus 687
Date: October 24, 1968

Operating Conditions: See Tables 2 through 5, Appendix A

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses 5	6	7	Average
1	Deceleration	3	6	1	5.8
2	40 mph at 40 hp	5	5		4.5
3	30 mph at 40 hp	5	5		4.5
4	Idle-Acceleration		5	5	6.5
5	Idle	2	2	6	6.4
6	20 mph at 40 hp	9	1		5.1
7	30 mph at 40 hp	6	4		5.4
8	20 mph at 40 hp	5	5		4.5
9	Deceleration		7	3	6.3
10	Idle-Acceleration		3	7	6.7
11	30 mph at 40 hp		10		6.0
12	20 mph at 40 hp	1	9		5.9
13	Idle	2	8		5.8
14	30 mph at 40 hp		1	9	6.9
15	Idle-Acceleration		1	9	6.9
16	Deceleration		2	8	6.8
17	40 mph at 40 hp	3	2	5	6.2
18	Idle	6	3	1	5.5
19	40 mph at 40 hp	3	2	5	6.2
20	20 mph at 40 hp		9	1	6.1
21	Deceleration			10	7.0
22	Idle		8	2	6.2
23	40 mph at 40 hp	2	7	1	5.9
24	Idle-Acceleration		5	5	6.5

TABLE 6B. VEHICLE ODOR EVALUATION RESULTS

("B" Burnt-Smoky Standard)

Vehicle: Bus 687
Date: October 24, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Average
1	Deceleration	2	8		1.8
2	40 mph at 40 hp	4	6		1.6
3	30 mph at 40 hp	4	5	1	1.7
4	Idle-Acceleration		10		2.0
5	Idle		10		2.0
6	20 mph at 40 hp	3	7		1.7
7	30 mph at 40 hp	2	8		1.8
8	20 mph at 40 hp	3	7		1.7
9	Deceleration		9	1	2.1
10	Idle-Acceleration		9	1	2.1
11	30 mph at 40 hp	1	8	1	2.0
12	20 mph at 40 hp	1	8	1	2.0
13	Idle	1	9		1.9
14	30 mph at 40 hp	1	9		1.9
15	Idle-Acceleration		8	2	2.2
16	Deceleration		8	2	2.2
17	40 mph at 40 hp	2	5	3	2.1
18	Idle	3	6	1	1.8
19	40 mph at 40 hp	3	4	3	2.0
20	20 mph at 40 hp		8	2	2.2
21	Deceleration		7	3	2.3
22	Idle		10		2.0
23	40 mph at 40 hp	1	9		2.0
24	Idle-Acceleration		9	1	1.9

TABLE 6C. VEHICLE ODOR EVALUATION RESULTS

("O" Oily Standard)

Vehicle: Bus 687
Date: October 24, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Average
1	Deceleration	3	7		1.7
2	40 mph at 40 hp	7	3		1.3
3	30 mph at 40 hp	6	4		1.4
4	Idle-Acceleration		10		2.0
5	Idle	5	5		1.5
6	20 mph at 40 hp	7	3		1.3
7	30 mph at 40 hp	7	3		1.3
8	20 mph at 40 hp	7	3		1.3
9	Deceleration		10		2.0
10	Idle-Acceleration		9	1	2.1
11	30 mph at 40 hp	2	7	1	1.9
12	20 mph at 40 hp	3	7		1.7
13	Idle	3	7		1.7
14	30 mph at 40 hp	1	9		1.9
15	Idle-Acceleration		10		2.0
16	Deceleration		9	1	2.1
17	40 mph at 40 hp	3	6	1	1.8
18	Idle	4	6		1.6
19	40 mph at 40 hp	3	6	1	1.8
20	20 mph at 40 hp	2	7	1	1.9
21	Deceleration	1	7	2	2.1
22	Idle	1	9		1.9
23	40 mph at 40 hp	2	8		1.8
24	Idle-Acceleration		10		2.0

TABLE 6D. VEHICLE ODOR EVALUATION RESULTS

("A" Aromatic Standard)

Vehicle: Bus 687
Date: October 24, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses 1	2	Average
1	Deceleration	8	2	1.2
2	40 mph at 40 hp	9	1	1.1
3	30 mph at 40 hp	7	3	1.3
4	Idle-Acceleration	7	3	1.3
5	Idle	7	3	1.3
6	20 mph at 40 hp	9	1	1.1
7	30 mph at 40 hp	9	1	1.1
8	20 mph at 40 hp	8	2	1.2
9	Deceleration	5	5	1.5
10	Idle-Acceleration	5	5	1.5
11	30 mph at 40 hp	7	3	1.3
12	20 mph at 40 hp	8	2	1.2
13	Idle	6	4	1.4
14	30 mph at 40 hp	7	3	1.3
15	Idle-Acceleration	6	4	1.4
16	Deceleration	6	4	1.4
17	40 mph at 40 hp	8	2	1.2
18	Idle	7	3	1.3
19	40 mph at 40 hp	7	3	1.3
20	20 mph at 40 hp	7	3	1.3
21	Deceleration	5	5	1.5
22	Idle	2	8	1.8
23	40 mph at 40 hp	7	3	1.3
24	Idle-Acceleration	6	4	1.4

TABLE 6E. VEHICLE ODOR EVALUATION RESULTS

("P" Pungent Standard)

Vehicle: Bus 687
Date: October 24, 1968

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Average
1	Deceleration		9	1	1.1
2	40 mph at 40 hp		9	1	1.1
3	30 mph at 40 hp		9	1	1.1
4	Idle-Acceleration		4	6	1.6
5	Idle		4	6	1.6
6	20 mph at 40 hp		10		1.0
7	30 mph at 40 hp		10		1.0
8	20 mph at 40 hp		10		1.0
9	Deceleration		6	4	1.4
10	Idle-Acceleration		6	4	1.4
11	30 mph at 40 hp		8	2	1.2
12	20 mph at 40 hp		10		1.0
13	Idle	2	8		0.8
14	30 mph at 40 hp	1	9		0.9
15	Idle-Acceleration		8	2	1.2
16	Deceleration		7	3	1.3
17	40 mph at 40 hp	1	7	2	0.9
18	Idle	1	8	1	1.0
19	40 mph at 40 hp		9	1	1.1
20	20 mph at 40 hp		9	1	1.1
21	Deceleration		7	3	1.3
22	Idle		9	1	1.1
23	40 mph at 40 hp		10		1.0
24	Idle-Acceleration		7	3	1.3

TABLE 7. COMPUTATION OF "U" STATISTICS TO ESTABLISH STATISTICAL DIFFERENCE BETWEEN BUS ODOR OPERATED WITH A NO. 1 AND NO. 2 DIESEL FUEL

Vehicle: Bus 687

Date: October 23-24, 1968
Operating Conditions: See Tables 2 through 5, Appendix A

Operating Conditions	Relative Ranking	Odor Quality					Operating Conditions	Relative Ranking	Odor Quality				
		"D"	"B"	"O"	"A"	"P"			"D"	"B"	"O"	"A"	"P"
I	1	1(1)	1	1	1	2(4)	IV	1	1(4)	2	1(4)	1(4)	1
20 mph	2	1	1	1	1	1(4)	Idle	2	2(4)	1	2(4)	1(4)	1(4)
40 hp	3	1	1(4)	1	1	1(4)		3	1	1(4)	1	2(4)	2(4)
	4	1	2(4)	1(4)	1	1(4)		4	2	2(4)	1(4)	2(4)	2(4)
	5	2(2)	2	2(4)	2	1		5	2	1(4)	2(4)	2(4)	2(4)
	6	2	1	2	2	2		6	2	1(4)	2	1	2(4)
	7	2	2	2	2	2		7	1	2(4)	2(4)	2	1
	8	2	2	2	2	2		8	1	2(4)	1(4)	1	1
	U_s(3)	0	2.5	0.5	0	3.5		U_s	6.5	8.5	6.5	6	6
II	1	1	1(4)	1	1	1	V	1	1	1	1(4)	1	2
30 mph	2	1	2(4)	1	2	1(4)	Idle-Acceleration	2	1	1	1(4)	1	1
40 hp	3	2	1	2	1	2(4)		3	1	1	1(4)	1	1(4)
	4	1	1	2	1	2(4)		4	1	1	2(4)	1	2(4)
	5	2	1(4)	2	1	1		5	2	2	2(4)	2	2(4)
	6	2	2(4)	2(4)	2	1(4)		6	2	2	2(4)	2	1
	7	2	2	1(4)	2	2(4)		7	2	2	1(4)	2	2
	8	1	2	1	2	2		8	2	2	2	2	1
	U_s	5	4	5.5	3	5.5		U_s	0	0	3.5	0	6
III	1	1	1	1	1(4)	1	VI	1	1	1	1	1(4)	2
40 mph	2	2	2	1(4)	2(4)	1(4)	Deceleration	2	1	1	1(4)	2(4)	2(4)
40 hp	3	1	2	1(4)	1	2(4)		3	1(4)	1(4)	2(4)	1	1(4)
	4	2	2	1(4)	1	2(4)		4	2(4)	2(4)	2(4)	1	2
	5	1	2(4)	2(4)	1	2(4)		5	1	2(4)	2(4)	1	2
	6	1	1(4)	2(4)	2	2(4)		6	2	1	1	2	1
	7	2	1	2(4)	2	1(4)		7	2	2	1	2	1
	8	2	1	2(4)	2	1(4)		8	2	2	2	2	1
	U_s	5	4.5	6	3.5	7.5		U_s	1.5	3	7.5	3.5	2.5

---

(1) "1" stands for EM-70-F (No. 1 Diesel).
(2) "2" stands for EM-29-F (No. 2 Diesel).
(3) U_s must equal 0, 1, or 2 to show significant difference for eight relative rankings.
(4) Designation shows equal values; therefore, the average of the sum of their relative rankings is used to compute(T).

38-A

EFFECT OF INJECTORS ON EMISSIONS

Detroit Diesel 6V-71 Engine

TABLE 8. VEHICLE ODOR EVALUATION SUMMARY

60N Injectors Installed

Vehicle: Bus 677
Date: April 30, 1969

Operating Conditions: See Tables 2 through 6, Appendix B

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	3.6	1.0	1.0	0.7	0.3
5	" "	3.6	1.1	0.9	0.7	0.7
12	" "	4.8	2.4	1.0	0.9	0.8
16	" "	4.7	1.4	1.2	1.0	0.8
		4.2	1.5	1.0	0.8	0.7
4	30 mph at 40 hp	3.9	1.4	0.9	0.7	0.4
7	" "	3.1	1.0	0.9	0.9	0.1
11	" "	2.8	1.0	0.8	0.5	0.2
13	" "	4.1	1.2	0.9	0.9	0.8
		3.5	1.2	0.9	0.8	0.4
1	40 mph at 40 hp	4.1	1.1	1.1	0.9	0.7
8	" "	3.5	1.1	0.9	0.8	0.7
10	" "	4.3	1.2	0.9	0.9	0.4
15	" "	3.1	0.9	0.8	0.8	0.6
		3.8	1.1	0.9	0.9	0.6
3	Idle	5.1	1.9	1.1	1.6	0.7
6	"	5.1	1.7	1.4	1.1	0.7
9	"	4.0	1.3	0.9	0.9	0.9
14	"	5.6	1.9	1.4	1.0	0.9
		5.0	1.7	1.2	1.2	0.8
17	Idle-Acceleration	5.2	1.6	1.4	0.9	0.9
20	" "	5.2	1.5	1.3	1.3	0.9
21	" "	5.2	1.4	1.3	1.2	0.8
24	" "	5.1	1.7	1.4	1.0	0.8
		5.2	1.6	1.4	1.1	0.9
18	Deceleration	4.0	1.4	1.0	1.0	0.9
19	"	4.7	1.4	0.9	0.9	0.8
22	"	3.6	1.1	0.9	0.7	0.5
23	"	3.1	1.1	0.8	0.8	0.4
		3.9	1.3	0.9	0.9	0.7

TABLE 9. VEHICLE ODOR EVALUATION SUMMARY
60X Injectors Installed

Vehicle: Bus 677
Date: May 1, 1969

Operating Conditions: See Tables 2 through 6, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	4.2	1.0	0.9	0.9	0.7
8	" "	2.9	1.8	0.8	0.8	0.3
11	" "	4.5	1.3	1.1	0.9	0.8
14	" "	4.0	1.3	0.9	1.0	0.3
		3.9	1.4	1.1	0.9	0.5
3	30 mph at 40 hp	3.8	1.0	1.1	0.9	0.5
5	" "	2.7	0.9	0.9	0.8	0.3
12	" "	3.5	0.9	0.9	0.6	0.4
16	" "	4.1	1.3	1.0	0.9	0.7
		3.5	1.0	1.0	0.8	0.4
4	40 mph at 40 hp	3.7	1.1	0.9	0.9	0.5
6	" "	3.6	1.0	1.0	0.9	0.3
9	" "	4.0	1.2	0.9	1.0	0.5
13	" "	3.7	1.0	0.8	0.9	0.4
		3.8	1.1	0.9	0.9	0.4
2	Idle	5.3	1.2	1.1	1.0	0.8
7	"	5.1	1.8	1.1	0.9	0.9
10	"	5.6	1.8	1.2	1.0	0.9
15	"	5.7	2.0	1.5	0.9	0.9
		5.4	1.7	1.2	1.0	0.9
18	Idle-Acceleration	5.3	1.6	1.0	1.1	0.9
20	" "	5.0	1.7	1.0	1.1	0.9
22	" "	4.8	1.5	1.3	1.1	0.6
24	" "	4.7	1.3	1.2	1.0	0.5
		5.0	1.5	1.1	1.1	0.7
17	Deceleration	4.0	1.3	0.9	1.0	0.4
19	"	4.2	1.3	1.0	1.0	0.8
21	"	3.1	1.0	1.0	0.7	0.6
23	"	3.6	1.2	0.9	1.0	0.6
		3.7	1.2	1.0	0.9	0.6

TABLE 10. SUMMARY OF EXHAUST EMISSION MEASUREMENTS

Vehicle: Bus 677
Date: April 30 and May 1, 1969

Operating Conditions: See Table 10, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Run No.	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes,* ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		NO_2, ppm		SO_2, ppm	
		60N	60X	60N	60X	60N	60X	60N	60X	60N	60X	60N	60X	60N	60X	60N	60X	60N	60X	60N	60X
I	2	530	695	4.0	4.1	626	232	2.1	1.3	20.4	22.3	2.9	2.9	1051	1040	1100	1140	40	40	0.30	0.36
20 mph	5	590	415	4.0	3.9	557	209	2.2	1.8	18.4	19.2	3.6	2.2	1132	1074	1060	1140	35	49	0.31	0.33
40 hp	12	610	400	4.3	3.9	487	209	2.1	1.8	21.3	20.4	4.4	2.9	1051	1086	1100	1140	32	44	0.31	0.33
	16	530	400	4.3	4.0	464	209	2.1	1.6	19.4	20.4	4.4	2.9	936	1086	1100	1140	32	40	0.35	0.33
"As-measured" Average		565	478	4.2	4.0	544	215	2	2	20	21	4	3	1043	1072	1090	1140	35	43	0.3	0.3
II	4	180	150	3.3	3.4	441	162	2.1	1.6	18.4	23.3	5.8	2.9	1063	1086	870	900	35	44	0.29	0.29
30 mph	7	165	150	3.3	3.4	464	186	1.8	1.6	20.4	21.3	6.6	2.2	809	1063	870	940	35	44	0.28	0.31
40 hp	11	130	130	3.4	3.2	338	186	1.8	1.5	19.2	21.3	5.8	1.4	843	1074	870	900	32	49	0.32	0.31
	13	150	115	3.3	3.1	464	186	2.1	1.4	19.4	20.2	6.6	2.2	809	1040	870	870	32	44	0.33	0.33
"As-measured" Average		156	136	3.3	3.3	427	180	2	2	19	21	6	2	881	1066	870	903	34	45	0.3	0.3
III	1	150	150	3.3	3.2	441	186	1.5	1.5	17.4	21.3	3.6	2.2	855	832	825	825	35	44	0.29	0.31
40 mph	8	130	130	3.1	3.1	557	186	1.9	1.5	19.4	20.4	9.5	2.9	785	785	720	790	32	44	0.32	0.31
40 hp	10	130	115	3.1	3.0	534	186	2.1	1.6	21.3	20.4	11.0	2.9	878	820	750	790	32	44	0.29	0.31
	15	130	115	3.2	2.9	464	186	1.8	1.6	20.4	20.4	8.0	1.4	820	762	720	750	32	44	0.31	0.32
"As-measured" Average		133	128	3.2	3.1	499	186	2	2	20	21	8	2	835	800	754	789	33	44	0.3	0.3
IV	3	270	305	0.9	1.0	371	139	2.6	2.1	30.1	31.0	3.6	6.6	266	266	250	250	40	49	0.28	0.30
Idle	6	270	270	0.9	0.9	371	162	2.3	1.8	31.0	27.0	3.6	5.8	266	266	250	280	44	49	0.28	0.30
	9	270	235	0.9	0.8	348	162	2.6	2.2	25.0	27.0	5.8	5.8	266	277	250	250	40	49	0.28	0.30
	14	270	235	0.9	0.8	325	162	2.4	1.8	32.0	28.1	4.4	5.8	266	243	280	250	35	44	0.29	0.30
"As-measured" Average		270	261	0.9	0.9	354	156	3	2	30	28	4	6	266	263	258	258	40	48	0.3	0.3

---

*Total as ppm formaldehyde.

TABLE 11. VEHICLE ODOR EVALUATION SUMMARY

STOCK MUFFLER INSTALLED

Vehicle: Bus 681
Date: May 28, 1969

Operating Conditions: See Tables 2 through 6, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	4.2	1.1	1.0	1.0	0.6
7	" "	5.0	1.7	1.3	1.1	0.2
12	" "	5.2	1.7	1.1	1.1	1.0
15	" "	5.5	1.9	1.2	1.1	0.9
		5.0	1.6	1.2	1.1	0.7
4	30 mph at 40 hp	4.3	1.1	1.1	1.0	0.7
5	" "	3.6	1.1	1.0	0.9	0.3
9	" "	4.3	1.0	1.0	1.0	0.6
16	" "	4.8	1.4	1.1	1.0	0.8
		4.3	1.2	1.1	1.0	0.6
2	40 mph at 40 hp	4.1	1.2	1.1	1.0	0.5
8	" "	4.9	1.6	1.2	0.9	0.3
10	" "	3.9	1.1	1.0	1.1	0.7
13	" "	4.8	1.4	1.3	1.0	1.0
		4.4	1.3	1.2	1.0	0.6
3	Idle	5.2	1.6	1.5	1.2	0.9
6	"	4.3	1.4	1.1	1.1	0.3
11	"	4.9	1.7	1.1	1.1	1.0
14	"	5.0	1.6	1.4	1.1	0.9
		4.9	1.6	1.3	1.1	0.8
18	Idle-Acceleration	6.6	2.1	1.7	1.5	1.1
20	" "	6.3	2.0	1.7	1.3	1.1
23	" "	6.2	2.1	1.6	0.9	1.3
24	" "	6.2	2.0	1.5	1.2	1.0
		6.3	2.1	1.6	1.2	1.1
17	Deceleration	6.1	2.0	1.7	1.4	0.9
19	"	6.8	2.1	1.8	1.5	1.1
21	"	6.8	2.0	1.9	1.5	1.4
22	"	5.9	1.9	1.8	1.5	1.2
		6.4	2.0	1.8	1.5	1.2

TABLE 12. VEHICLE ODOR EVALUATION SUMMARY
EXPERIMENTAL 60N INJECTORS INSTALLED

Vehicle: Bus 681
Date: May 29, 1969

Operating Conditions: See Tables 2 through 6, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	20 mph at 40 hp	2.3	0.8	0.7	0.8	0
6	" "	2.6	0.8	0.8	0.5	0.2
9	" "	2.7	0.8	0.7	0.5	0
15	" "	2.8	0.8	0.7	0.6	0.1
		2.6	0.8	0.7	0.6	0.1
1	30 mph at 40 hp	3.7	1.0	1.0	1.0	0.4
7	" "	2.1	0.8	0.8	0.5	0.2
10	" "	2.4	0.8	0.8	0.8	0.1
14	" "	3.7	1.0	1.0	1.0	0.3
		3.0	0.9	0.9	0.8	0.3
2	40 mph at 40 hp	2.6	1.0	0.7	0.6	0.1
5	" "	2.7	1.0	0.7	0.7	0.1
11	" "	2.7	0.8	0.8	0.7	0.3
13	" "	2.1	0.8	0.8	0.5	0.2
		2.5	0.9	0.8	0.6	0.2
4	Idle	4.2	1.1	0.8	1.0	0.7
8	"	4.9	1.1	1.0	1.0	0.8
12	"	4.4	1.3	1.0	1.1	0.6
16	"	4.2	1.1	0.7	0.8	0.5
		4.4	1.2	0.9	1.0	0.7
17	Idle-Acceleration	4.6	1.6	1.0	1.1	0.6
19	" "	4.9	1.4	1.1	1.1	0.6
21	" "	4.4	1.2	1.0	1.0	0.5
23	" "	5.2	1.6	1.2	1.0	0.6
		4.8	1.4	1.1	1.1	0.6
18	Deceleration	4.0	1.7	1.0	1.0	0.4
20	"	3.3	1.0	0.6	0.8	0.5
22	"	4.0	1.1	1.0	0.9	0.5
24	"	4.2	1.1	0.8	1.1	0.6
		3.9	1.2	0.9	1.0	0.5

TABLE 13. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS 60S INJECTORS VS 60N EXPERIMENTAL INJECTORS

Vehicle: Bus 681
Date: May 28 and May 29, 1969

Operating Conditions: See Table 10, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO₂, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes, ppm		Formaldehyde, ppm		NO$_x$, ppm		NO, ppm		NO$_2$, ppm		SO$_2$, ppm	
	60S	60N	60S	60N	60S	60N	60S	60N	60S	60N	60S	60N	60S	60N	60S	60N	60S	60N	60S	60N
I	1155	360	5.6	5.1	1462	441	4.7	2.2	33.0	14.6	11.0	4.4	889	924	790	980	49	44	0.15	0.17
20 mph	975	435	5.7	5.3	1253	487	5.1	2.7	30.3	14.6	9.6	3.7	878	924	790	980	58	44	0.17	0.15
40 hp	865	380	5.6	5.3	1160	464	4.9	2.6	33.6	12.6	10.0	5.1	889	936	825	980	54	40	0.14	0.17
	885	285	5.4	4.8	1183	441	5.9	2.2	33.8	14.6	12.0	3.7	832	936	825	940	54	44	0.17	0.14
"As-measured" Average	970	365	5.6	5.4	1265	458	5	2	33	14	11	4	872	930	808	970	54	43	0.2	0.2
II	250	200	4.8	4.3	1067	371	3.7	2.6	16.5	13.6	5.9	2.2	739	762	640	750	54	44	0.90	0.83
30 mph	270	215	4.7	4.3	1114	371	3.8	2.4	17.5	16.5	7.3	2.9	612	797	640	750	54	44	0.17	0.21
40 hp	250	180	4.4	4.3	1090	371	3.5	2.5	16.9	16.5	7.5	2.9	762	774	600	750	54	49	0.11	0.17
	250	180	4.3	4.2	974	394	3.7	2.2	20.1	15.5	7.2	3.7	705	820	640	720	58	49	0.13	0.17
"As-measured" Average	255	194	4.6	4.3	1061	377	4	2	18	16	7	3	705	788	630	743	55	47	0.3	0.3
III	215	200	4.6	4.2	882	186	3.5	2.1	25.3	14.6	9.6	2.2	647	762	570	680	49	40	0.15	0.19
40 mph	215	200	4.3	4.1	835	232	3.2	2.0	23.5	16.5	10.3	3.7	647	647	570	680	49	40	0.14	0.13
40 hp	215	165	4.3	4.2	905	278	3.2	2.1	16.9	13.6	9.1	3.7	624	670	570	640	49	44	0.10	0.15
	200	165	4.2	4.1	835	278	3.7	2.1	19.6	15.5	10.9	3.7	612	774	570	640	49	44	0.18	0.18
"As-measured" Average	211	183	4.4	4.2	864	244	3	2	21	15	10	3	633	713	570	660	49	42	0.1	0.2
IV	235	285	1.2	1.1	534	302	3.3	2.7	18.5	18.4	6.6	5.2	219	289	175	280	58	54	0.57	0.51
Idle	235	285	1.4	1.1	510	302	3.5	2.6	12.7	16.5	7.3	4.4	266	289	210	320	58	54	0.68	0.58
	235	235	1.1	1.2	487	302	3.1	2.6	20.1	16.5	7.6	5.9	219	337	210	280	54	54	0.49	0.58
	235	250	1.1	1.2	487	302	3.5	2.3	19.6	17.4	6.2	6.6	219	243	210	280	58	54	0.53	0.65
"As-measured" Average	235	264	1.2	1.2	505	302	4	3	18	17	7	6	231	287	201	290	57	54	0.6	0.6

TABLE 14. VEHICLE ODOR EVALUATION SUMMARY
Stock "S" Injectors Installed

Vehicle: Bus 681 Fuel: EM-70-F (No. 1 Diesel)
Date: July 30, 1969

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	5.6	1.9	1.3	1.0	1.0
8	" "	5.3	1.6	1.3	1.0	1.0
12	" "	4.9	1.6	1.0	1.1	0.9
15	" "	5.3	1.7	1.1	1.1	1.0
		5.3	1.7	1.2	1.1	1.0
4	30 mph at 40 hp	5.7	2.0	1.6	1.0	1.0
5	" "	4.4	1.3	1.0	1.1	0.9
9	" "	5.7	1.7	1.6	1.0	1.0
16	" "	4.7	1.6	1.0	1.1	1.0
		5.1	1.7	1.3	1.1	1.0
2	40 mph at 40 hp	6.0	1.9	1.4	1.1	1.0
7	" "	4.7	1.4	1.1	1.1	0.9
10	" "	4.7	1.7	1.4	1.1	0.9
13	" "	5.4	1.7	1.4	1.0	1.0
		5.2	1.7	1.3	1.1	1.0
3	Idle	4.9	1.6	1.0	1.1	0.9
6	"	4.4	1.3	1.1	1.1	1.0
11	"	4.9	1.6	1.3	0.9	0.7
14	"	4.1	1.3	1.3	1.1	0.9
		4.6	1.5	1.2	1.1	0.9
17	Idle-Acceleration	6.0	1.9	1.4	1.3	1.0
20	" "	7.4	2.1	1.7	1.7	1.3
22	" "	5.9	2.0	1.4	1.1	1.0
23	" "	5.7	1.9	1.4	1.1	1.3
		6.3	2.0	1.5	1.3	1.2
18	Deceleration	6.0	2.0	1.3	1.4	1.0
19	"	5.4	1.7	1.0	1.3	1.0
21	"	4.9	1.9	1.0	1.3	1.0
24	"	5.1	1.4	1.1	1.1	1.0
		5.4	1.8	1.1	1.3	1.0

TABLE 15. VEHICLE ODOR EVALUATION SUMMARY
Low Sac Injectors Installed

Vehicle: Bus 681
Date: July 29, 1969

Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	2.0	0.9	0.9	1.0	0.4
8	" "	3.3	1.4	1.0	0.8	0.6
12	" "	3.3	1.2	1.0	0.8	0.5
14	" "	3.1	1.0	0.9	1.0	0.4
		2.9	1.1	1.0	0.9	0.5
4	30 mph at 40 hp	2.4	0.9	0.9	0.8	0.4
5	" "	1.9	0.9	0.9	0.5	0.4
9	" "	2.3	0.9	0.9	0.9	0.1
16	" "	2.9	1.0	1.0	0.9	0.8
		2.4	0.9	0.9	0.8	0.4
1	40 mph at 40 hp	2.4	0.9	0.9	0.9	0.4
6	" "	2.4	1.0	0.8	0.8	0.4
11	" "	4.3	1.2	0.8	1.2	0.5
13	" "	2.5	1.0	1.0	0.8	0.4
		2.9	1.0	0.9	0.9	0.4
3	Idle	3.8	1.0	1.0	1.0	0.5
7	"	4.3	1.2	1.2	1.2	1.0
10	"	3.3	0.9	1.0	1.0	0.5
15	"	4.5	1.2	1.2	1.2	0.8
		4.0	1.1	1.1	1.1	0.7
18	Idle-Acceleration	4.6	1.5	1.3	1.3	1.0
19	" "	4.6	1.6	1.2	1.0	1.0
21	" "	4.5	1.6	1.3	1.2	1.0
24	" "	4.8	1.6	1.5	1.2	0.9
		4.6	1.6	1.3	1.2	1.0
17	Deceleration	2.6	0.8	0.9	1.0	0.6
20	"	3.0	1.2	1.2	1.0	0.4
22	"	4.1	1.4	1.2	1.2	0.9
23	"	2.9	0.9	1.0	0.9	0.5
		3.2	1.1	1.1	1.0	0.6

TABLE 16 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS
60S Injectors vs Low Sac Injectors

(As-Measured)

Vehicle: Bus 681
Date: July 29 and 30, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm		CO_2, percent		HHC, ppm		Acrolein, ppm		Aldehydes,* ppm		Formaldehyde, ppm		NO_x, ppm		NO, ppm		SO_2, ppm	
	60S	Low Sac	60S	Low Sac	60S	Low Sac	60S	Low Sac	60S	Low Sac	60S	Low Sac	60S	Low Sac	60S	Low Sac	60S	Low Sac
20 mph	685	324	5.6	5.4	2012	253	2.7	2.2	30.0	18.8	11.8	3.2	1328	1340	775	1050	1.1	1.5
40 hp	611	194	5.6	5.6	2061	255	4.3	1.6	38.1	19.9	5.4	1.7	1282	1317	800	1050	1.2	1.2
	648	194	5.3	5.6	2156	227	2.7	1.7	24.3	20.0	5.8	1.7	1247	1386	725	1050	1.4	1.7
	705	194	5.3	5.4	2000	252	2.1	1.5	26.0	20.1	3.1	1.7	1109	1363	675	1050	1.4	1.5
Average	662	227	5.5	5.5	2057	248	3	2	30	20	7	2	1242	1352	744	1050	1.3	1.5
30 mph	234	134	4.4	4.6	1986	255	2.6	1.5	26.4	20.6	5.2	1.6	970	1201	600	825	1.1	1.4
40 hp	234	149	4.7	4.9	1922	216	2.2	1.4	28.9	20.8	5.2	1.7	1016	1074	625	825	1.2	1.5
	210	98	4.8	4.8	1934	215	2.6	1.4	23.1	21.0	1.5	1.7	1040	1097	625	900	1.4	1.7
	234	91	4.6	5.0	2024	228	2.0	1.6	28.0	17.8	3.5	0.9	1040	1167	575	875	1.4	1.2
Average	228	118	4.6	4.8	1967	229	2	2	27	20	4	2	1017	1135	606	856	1.3	1.5
40 mph	194	119	4.4	4.5	1846	204	2.0	2.5	24.4	21.1	6.8	5.3	901	1040	575	775	1.2	1.2
40 hp	186	119	4.4	4.3	1781	178	2.3	1.2	25.9	20.7	5.4	1.7	878	959	575	750	1.2	1.4
	179	77	4.4	4.4	1919	191	2.5	1.6	24.5	21.0	3.4	2.5	878	993	550	775	1.2	1.2
	179	77	4.4	4.8	1882	178	2.2	1.4	28.0	20.0	3.0	2.5	912	970	575	750	1.2	1.4
Average	185	98	4.4	4.5	1857	188	2	2	26	21	5	3	892	991	569	763	1.2	1.3
Idle	226	179	1.2	1.1	899	195	2.4	2.0	29.4	25.0	7.7	3.3	289	416	200	275	0.6	0.6
	218	114	1.1	1.4	899	181	1.6	1.7	29.3	22.9	8.0	5.8	370	393	200	300	0.6	0.6
	202	119	1.3	1.1	950	181	2.3	1.7	22.7	22.8	6.6	3.3	335	404	225	275	0.6	0.6
	202	116	1.1	1.2	888	194	2.4	1.6	24.0	21.0	2.6	2.5	358	370	225	275	0.6	0.6
Average	212	132	1.2	1.2	909	188	2	2	26	23	6	4	338	396	213	281	0.6	0.6

---

*Total as ppm formaldehyde.

APPENDIX F

(INSTRUMENT--ODOR PANEL CORRELATION) ODOR, SMOKE, AND CHEMISTRY RESULTS FROM VEHICLES AND ENGINES

TABLE 1. ODOR EVALUATION SUMMARY--CORRELATION STUDY

(2 Cycle)

Vehicle: Bus 683, 6V-71E
Date: January 28, 1969

Operating Conditions: See Tables 2 through 5, Appendix A
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	Average Panel Responses "D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	6.9	2.2	2.0	1.0	1.0
7	" "	6.4	2.1	2.0	1.3	1.0
10	" "	6.0	2.0	1.8	1.5	0.9
14	" "	6.7	2.0	1.8	1.4	1.2
		6.5	2.1	1.9	1.3	1.0
2	30 mph at 40 hp	5.7	1.6	1.6	1.0	0.7
5	" "	5.7	1.7	1.5	1.4	0.9
9	" "	5.8	1.8	1.6	1.2	1.0
15	" "	6.4	2.1	1.7	1.4	1.1
		5.9	1.8	1.6	1.3	0.9
3	40 mph at 40 hp	6.1	1.9	1.9	1.1	1.0
6	" "	5.5	1.8	1.6	1.5	0.9
11	" "	6.4	1.9	1.9	1.4	1.1
13	" "	6.6	2.0	1.8	1.6	1.0
		6.2	1.9	1.8	1.4	1.0
4	Idle	5.9	1.7	1.5	1.4	1.2
8	"	5.5	1.9	1.1	1.3	0.8
12	"	5.9	1.9	1.8	1.2	1.1
16	"	6.4	2.2	1.7	1.4	1.1
		5.9	1.9	1.5	1.3	1.1

TABLE 1A. ODOR EVALUATION RESULTS--CORRELATION STUDY
("D" Diesel Composite Results)

Vehicle: Bus 683
Date: January 28, 1969

Operating Conditions: See Tables 2 through 5 in Appendix A
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses 5	6	7	8	Average
1	20 mph at 40 hp		2	7	1	6.9
2	30 mph at 40 hp	3	7			5.7
3	40 mph at 40 hp	3	3	4		6.1
4	Idle	1	9			5.9
5	30 mph at 40 hp	3	7			5.7
6	40 mph at 40 hp	5	5			5.5
7	20 mph at 40 hp		6	4		6.4
8	Idle	5	5			5.5
9	30 mph at 40 hp	5	2	3		5.8
10	20 mph at 40 hp		10			6.0
11	40 mph at 40 hp	2	2	6		6.4
12	Idle	1	9			5.9
13	40 mph at 40 hp		4	6		6.6
14	20 mph at 40 hp		3	7		6.7
15	30 mph at 40 hp		7	2	1	6.4
16	Idle		8		2	6.4

TABLE 1B. ODOR EVALUATION RESULTS--CORRELATION STUDY
("B" Burnt-Smoky Standard)

Vehicle: Bus 683
Date: January 28, 1969

Operating Conditions: See Tables 2 through 5 in Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses 1	2	3	Average
1	20 mph at 40 hp	1	6	3	2.2
2	30 mph at 40 hp	4	6		1.6
3	40 mph at 40 hp	3	5	2	1.9
4	Idle	3	7		1.7
5	30 mph at 40 hp	3	7		1.7
6	40 mph at 40 hp	2	8		1.8
7	20 mph at 40 hp		9	1	2.1
8	Idle	2	7	1	1.9
9	30 mph at 40 hp	3	6	1	1.8
10	20 mph at 40 hp		10		2.0
11	40 mph at 40 hp	2	7	1	1.9
12	Idle	1	9		1.9
13	40 mph at 40 hp		10		2.0
14	20 mph at 40 hp		10		2.0
15	30 mph at 40 hp		9	1	2.1
16	Idle		8	2	2.2

TABLE 1C. ODOR EVALUATION RESULTS--CORRELATION STUDY
("O" Oily Standard)

Vehicle: Bus 683
Date: January 28, 1969

Operating Conditions: See Tables 2 through 5 in Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"O" Oily Responses 1	2	3	Average
1	20 mph at 40 hp	1	8	1	2.0
2	30 mph at 40 hp	4	6		1.6
3	40 mphat 40 hp	3	5	2	1.9
4	Idle	5	5		1.5
5	30 mph at 40 hp	5	5		1.5
6	40 mph at 40 hp	4	6		1.6
7	20 mph at 40 hp	1	8	1	2.0
8	Idle	9	1		1.1
9	30 mph at 40 hp	5	4	1	1.6
10	20 mph at 40 hp	3	6	1	1.8
11	40 mph at 40 hp	2	7	1	1.9
12	Idle	2	8		1.8
13	40 mph at 40 hp	3	6	1	1.8
14	20 mph at 40 hp	2	8		1.8
15	30 mph at 40 hp	3	7		1.7
16	Idle	3	7		1.7

TABLE 1D. ODOR EVALUATION RESULTS--CORRELATION STUDY
("A" Aromatic Standard)

Vehicle: Bus 683
Date: January 28, 1969

Operating Conditions: See Tables 2 through 5 in Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Average
1	20 mph at 40 hp	2	6	2	1.0
2	30 mph at 40 hp	1	8	1	1.0
3	40 mph at 40 hp		9	1	1.1
4	Idle		6	4	1.4
5	30 mph at 40 hp		6	4	1.4
6	40 mph at 40 hp		5	5	1.5
7	20 mph at 40 hp		7	3	1.3
8	Idle		7	3	1.3
9	30 mph at 40 hp		8	2	1.2
10	20 mph at 40 hp		5	5	1.5
11	40 mph at 40 hp		6	4	1.4
12	Idle		8	2	1.2
13	40 mph at 40 hp		4	6	1.6
14	20 mph at 40 hp		6	4	1.4
15	30 mph at 40 hp		6	4	1.4
16	Idle		6	4	1.4

TABLE 1E. ODOR EVALUATION RESULTS--CORRELATION STUDY
("P" Pungent Standard)

Vehicle: Bus 683
Date: January 28, 1969

Operating Conditions: See Tables 2 through 5 in Appendix A
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Average
1	20 mph at 40 hp	2	6	2	1.0
2	30 mph at 40 hp	4	5	1	0.7
3	40 mph at 40 hp	1	8	1	1.0
4	Idle		8	2	1.2
5	30 mph at 40 hp	2	7	1	0.9
6	40 mph at 40 hp	1	9		0.9
7	20 mph at 40 hp	1	8	1	1.0
8	Idle	2	8		0.8
9	30 mph at 40 hp		10		1.0
10	20 mph at 40 hp	1	9		0.9
11	40 mph at 40 hp	1	7	2	1.1
12	Idle		9	1	1.1
13	40 mph at 40 hp		10		1.0
14	20 mph at 40 hp		8	2	1.2
15	30 mph at 40 hp		9	1	1.1
16	Idle		9	1	1.1

TABLE 2. ODOR EVALUATION SUMMARY--CORRELATION STUDY

(4 Cycle)

Engine: Cummins NH-220
Date: January 29, 1969

Dilution Level: 100:1
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	Average Panel Responses				
		"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	125 hp at 1500 rpm	3.3	1.0	0.9	0.9	0.2
9	" "	4.6	1.0	1.0	0.8	0.5
11	" "	2.7	1.1	0.8	0.5	0.3
15	" "	3.5	1.0	1.0	0.8	0.3
		3.5	1.0	0.9	0.8	1.4
1	125 hp at 1800 rpm	3.2	1.0	0.9	0.7	0.5
6	" "	3.9	1.0	1.0	0.9	0.8
10	" "	3.9	1.1	1.0	0.7	0.5
13	" "	3.8	1.0	1.0	0.8	0.4
		3.7	1.0	1.0	0.8	0.6
3	125 hp at 2100 rpm	4.7	1.4	1.0	0.8	0.6
5	" "	3.7	1.0	1.0	0.9	0.5
7	" "	5.0	1.5	1.0	0.9	0.9
14	" "	4.6	1.3	1.0	0.9	0.7
		4.5	1.3	1.0	0.9	0.7
4	Idle	5.3	1.4	1.2	1.2	0.7
8	"	5.8	2.1	1.4	1.1	0.9
12	"	5.5	1.6	1.0	1.0	0.9
16	"	5.0	1.6	1.1	1.0	0.9
		5.4	1.7	1.2	1.1	0.9

TABLE 2A. ODOR EVALUATION RESULTS--CORRELATION STUDY

("D" Diesel Composite Results)

Engine: Cummins NH-220
Date: January 29, 1969

Dilution Level: 100:1
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Diesel Composite Responses					
		2	3	4	5	6	Average
1	125 hp at 1800 rpm	2	4	4			3.2
2	125 hp at 1500 rpm	2	3	5			3.3
3	125 hp at 2100 rpm			3	7		4.7
4	Idle				7	3	5.3
5	125 hp at 2100 rpm		3	7			3.7
6	125 hp at 1800 rpm		1	9			3.9
7	125 hp at 2100 rpm				10		5.0
8	Idle				2	8	5.8
9	125 hp at 1500 rpm			4	6		4.6
10	125 hp at 1800 rpm		4	3	3		3.9
11	125 hp at 1500 rpm	3	7				2.7
12	Idle				5	5	5.5
13	125 hp at 1800 rpm		2	8			3.8
14	125 hp at 2100 rpm		1	4	3	2	4.6
15	125 hp at 1500 rpm		5	5			3.5
16	Idle				10		5.0

TABLE 2B. ODOR EVALUATION RESULTS--CORRELATION STUDY

("B" Burnt-Smoky Standard)

Engine: Cummins NH-220
Date: January 29, 1969

Dilution Level: 100:1
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"B" Burnt-Smoky Responses			
		1	2	3	Average
1	125 hp at 1800 rpm	10			1.0
2	125 hp at 1500 rpm	10			1.0
3	125 hp at 2100 rpm	6	4		1.4
4	Idle	6	4		1.4
5	125 hp at 2100 rpm	10			1.0
6	125 hp at 1800 rpm	10			1.0
7	125 hp at 2100 rpm	5	5		1.5
8	Idle		9	1	2.1
9	125 hp at 1500 rpm	10			1.0
10	125 hp at 1800 rpm	9	1		1.1
11	125 hp at 1500 rpm	9	1		1.1
12	Idle	4	6		1.6
13	125 hp at 1800 rpm	10			1.0
14	125 hp at 2100 rpm	7	3		1.3
15	125 hp at 1500 rpm	10			1.0
16	Idle	4	6		1.6

TABLE 2C. ODOR EVALUATION RESULTS--CORRELATION STUDY

("O" Oily Standard)

Engine: Cummins NH-220
Date: January 29, 1969

Dilution Level: 100:1
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"O" Oily Responses 0	1	2	Average
1	125 hp at 1800 rpm	1	9		0.9
2	125 hp at 1500 rpm	1	9		0.9
3	125 hp at 2100 rpm		10		1.0
4	Idle		8	2	1.2
5	125 hp at 2100 rpm		10		1.0
6	125 hp at 1800 rpm		10		1.0
7	125 hp at 2100 rpm		10		1.0
8	Idle		6	4	1.4
9	125 hp at 1500 rpm		10		1.0
10	125 hp at 1800 rpm		10		1.0
11	125 hp at 1500 rpm	2	8		0.8
12	Idle		10		1.0
13	125 hp at 1800 rpm		10		1.0
14	125 hp at 2100 rpm		10		1.0
15	125 hp at 1500 rpm		10		1.0
16	Idle		9	1	1.1

TABLE 2D. ODOR EVALUATION RESULTS--CORRELATION STUDY

("A" Aromatic Standard)

Engine: Cummins NH-220
Date: January 29, 1969

Dilution Level: 100:1
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"A" Aromatic Responses			
		0	1	2	Average
1	125 hp at 1800 rpm	3	7		0.7
2	125 hp at 1500 rpm	1	9		0.9
3	125 hp at 2100 rpm	2	8		0.8
4	Idle		8	2	1.2
5	125 hp at 2100 rpm	1	9		0.9
6	125 hp at 1800 rpm	1	9		0.9
7	125 hp at 2100 rpm	1	9		0.9
8	Idle		9	1	1.1
9	125 hp at 1500 rpm	2	8		0.8
10	125 hp at 1800 rpm	3	7		0.7
11	125 hp at 1500 rpm	5	5		0.5
12	Idle		10		1.0
13	125 hp at 1800 rpm	2	8		0.8
14	125 hp at 2100 rpm	1	9		0.9
15	125 hp at 1500 rpm	2	8		0.8
16	Idle		10		1.0

TABLE 2E. ODOR EVALUATION RESULTS--CORRELATION STUDY

("P" Pungent Standard)

Engine: Cummins NH-220
Date: January 29, 1969

Dilution Level: 100:1
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"P" Pungent Responses 0	1	2	Average
1	125 hp at 1800 rpm	5	5		0.5
2	125 hp at 1500 rpm	8	2		0.2
3	125 hp at 2100 rpm	4	6		0.6
4	Idle	3	7		0.7
5	125 hp at 2100 rpm	5	5		0.5
6	125 hp at 1800 rpm	2	8		0.8
7	125 hp at 2100 rpm	1	9		0.9
8	Idle	1	9		0.9
9	125 hp at 1500 rpm	5	5		0.5
10	125 hp at 1800 rpm	5	5		0.5
11	125 hp at 1500 rpm	7	3		0.3
12	Idle	1	9		0.9
13	125 hp at 1800 rpm	6	4		0.4
14	125 hp at 2100 rpm	3	7		0.7
15	125 hp at 1500 rpm	7	3		0.3
16	Idle	1	9		0.9

TABLE 3. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS--CORRELATION STUDY

Date: January 28 & 29, 1969

Fuel: EM-29-F (No. 2 Diesel)

Operating Condition	CO, ppm		CO₂, percent		HHC, ppm		Acrolein, ppm		Aliphatic Aldehydes, ppm		Formaldoyhde,* ppm		NO$_x$, ppm		NO, ppm		SO$_2$, ppm		Adjusting Factor	
	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220	6V-71	NH-220
20 mph, 40 hp	1690	1490	4.1	5.1	1856	52	3.4	1.9	6.2	20.3	6.3	8.1	785	900	720	1020	0.31	0.20		
(6V-71)	1640	1560	4.1	5.5	1879	70	6.9	2.9	14.5	18.7	7.3	7.5	866	912	870	940	0.36	0.32		
125 hp at 1500 rpm	1810	1220	4.1	5.4	1856	70	6.0	2.5	19.2	18.7	9.7	7.5	669	866	870	1020	0.42	0.32		
(NH-220)	1390	1290	4.0	5.5	1926	46	6.0	2.5	14.0	23.4	6.7	8.5	785	889	825	1100	0.31	0.43		
"As-measured" average	1633	1390	4.1	5.4	1879	60	5	2	13	20	7	7	776	892	821	1020	0.3	0.3	3.52	2.71
Adjusted average†	5748	3767	14.43	14.63	6614	163	19	6	47	55	26	21	2734	2417	2890	2764	1.2	0.8		
30 mph, 40 hp	340	1000	4.3	4.6	1740	58	3.4	1.3	17.9	19.5	4.5	3.2	877	750	910	720	0.20	0.17		
(6V-71)	325	1085	4.1	5.5	1856	65	3.4	2.8	17.3	17.1	4.5	6.0	831	669	825	750	0.15	0.32		
125 hp at 1800 rpm	285	1040	3.6	5.1	1740	139	3.4	3.2	13.3	22.3	5.5	4.2	866	681	825	720	0.14	0.31		
(NH-220)	270	950	3.4	5.1	1810	116	3.8	3.1	10.3	20.0	3.4	5.1	554	716	825	750	0.21	0.31		
"As-measured" average	305	1019	3.9	5.1	1787	95	3	2	13	19	4	4	782	704	846	735	0.1	0.2	3.81	2.88
Adjusted average†	1162	2935	14.86	14.69	6808	274	13	7	51	56	17	13	2981	2029	3223	2117	0.6	0.8		
40 mph, 40 hp	235	1065	4.0	5.8	1624	71	1.4	2.6	11.8	21.5	5.3	7.2	785	462	790	570	0.14	0.23		
(6V-71)	235	1040	3.8	6.2	1647	77	1.8	2.8	10.9	21.0	3.6	5.0	716	485	720	570	0.16	0.24		
125 hp at 2100 rpm	235	1105	3.4	6.1	1647	84	4.2	3.2	11.7	20.9	5.9	6.7	693	542	790	600	0.31	0.27		
(NH-220)	235	950	3.5	6.2	1647	93	3.2	2.4	18.2	23.4	6.9	9.3	600	519	750	600	0.21	0.41		
"As-measured" average	235	1040	3.7	6.1	1641	81	2	2	13	21	5	7	698	502	763	585	0.2	0.2	4.02	2.42
Adjusted average†	946	2517	14.89	14.76	6605	196	10	6	52	52	21	17	2812	1215	3072	1416	0.8	0.7		
Idle	340	180	0.9	0.7	557	129	4.03	2.3	15.5	19.6	4.5	7.4	265	115	250	175	0.16	0.16		
	285	200	0.8	0.8	650	163	4.29	2.3	20.1	21.6	8.6	6.5	242	115	250	220	0.18	0.22		
	285	200	0.8	0.8	464	139	4.53	2.1	24.3	24.2	9.7	7.5	196	138	250	250	0.19	0.28		
	305	220	0.9	0.9	641	93	4.78	2.3	16.9	21.0	9.4	6.7	265	138	220	250	0.17	0.24		
"As-measured" average	304	200	0.9	0.8	578	116	4	2	19	21	8	7	242	127	243	224	0.1	0.1	16.15	18.30
Adjusted average†	4909	3660	1453	14.64	9324.0	2088	71	41	311	396	130	129	3917	2325	3924	4099.20	290.7	329.4		

---

*As ppm formaldehyde.

†Adjusted average values based on 15 divided by the percent (CO and CO$_2$) in the exhaust using "as-measured" CO and CO$_2$ measurements.

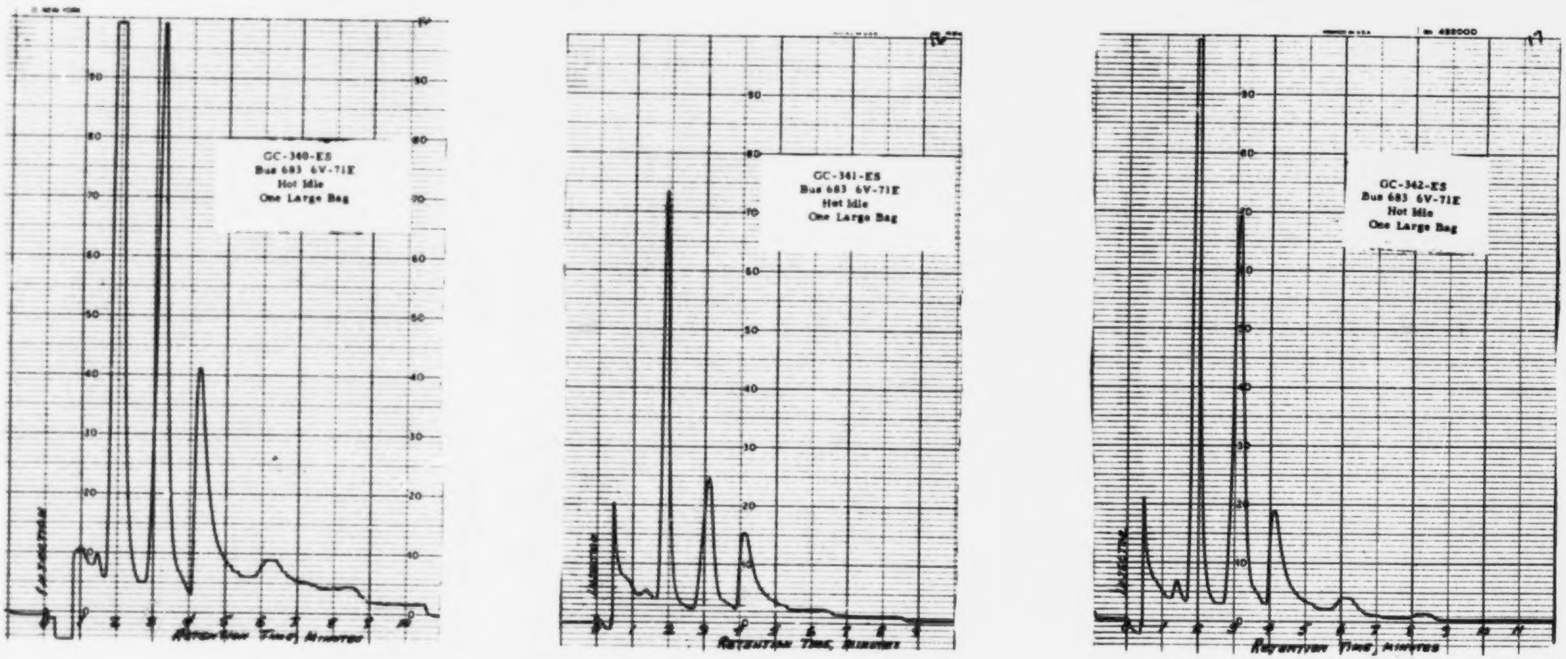


FIGURE 1. GAS CHROMATOGRAMS OF BUS 683 6V 71E EXHAUST CONDENSATE AT HOT IDLE (STOCK)--TRAPPED FROM ONE LARGE BAG, STORED OVERNIGHT

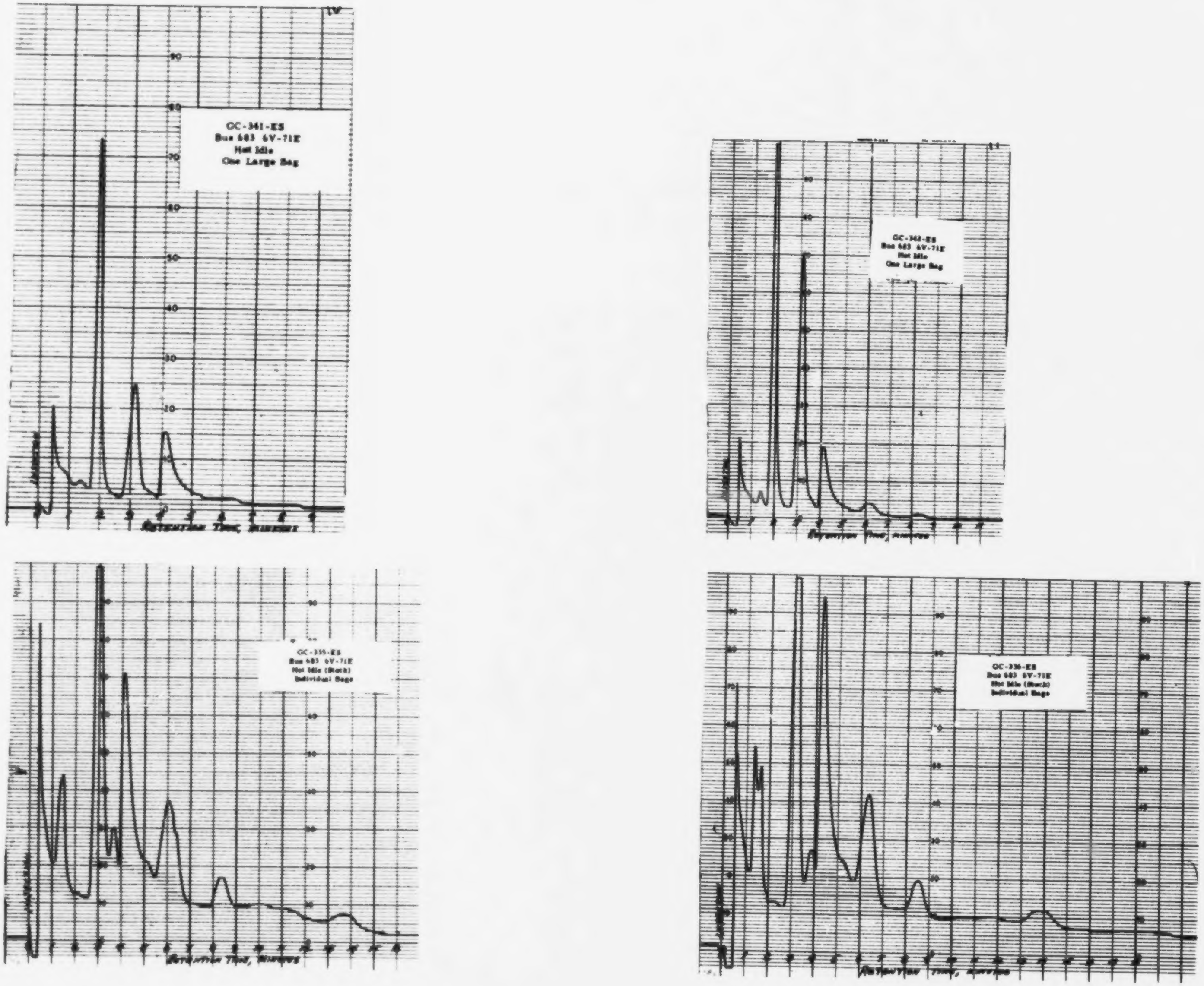


FIGURE 2. GAS CHROMATOGRAMS OF BUS 683 6V-71E EXHAUST CONDENSATE AT HOT IDLE (STOCK MUFFLER)--TRAPPED WITH AND WITHOUT OVERNIGHT STORAGE

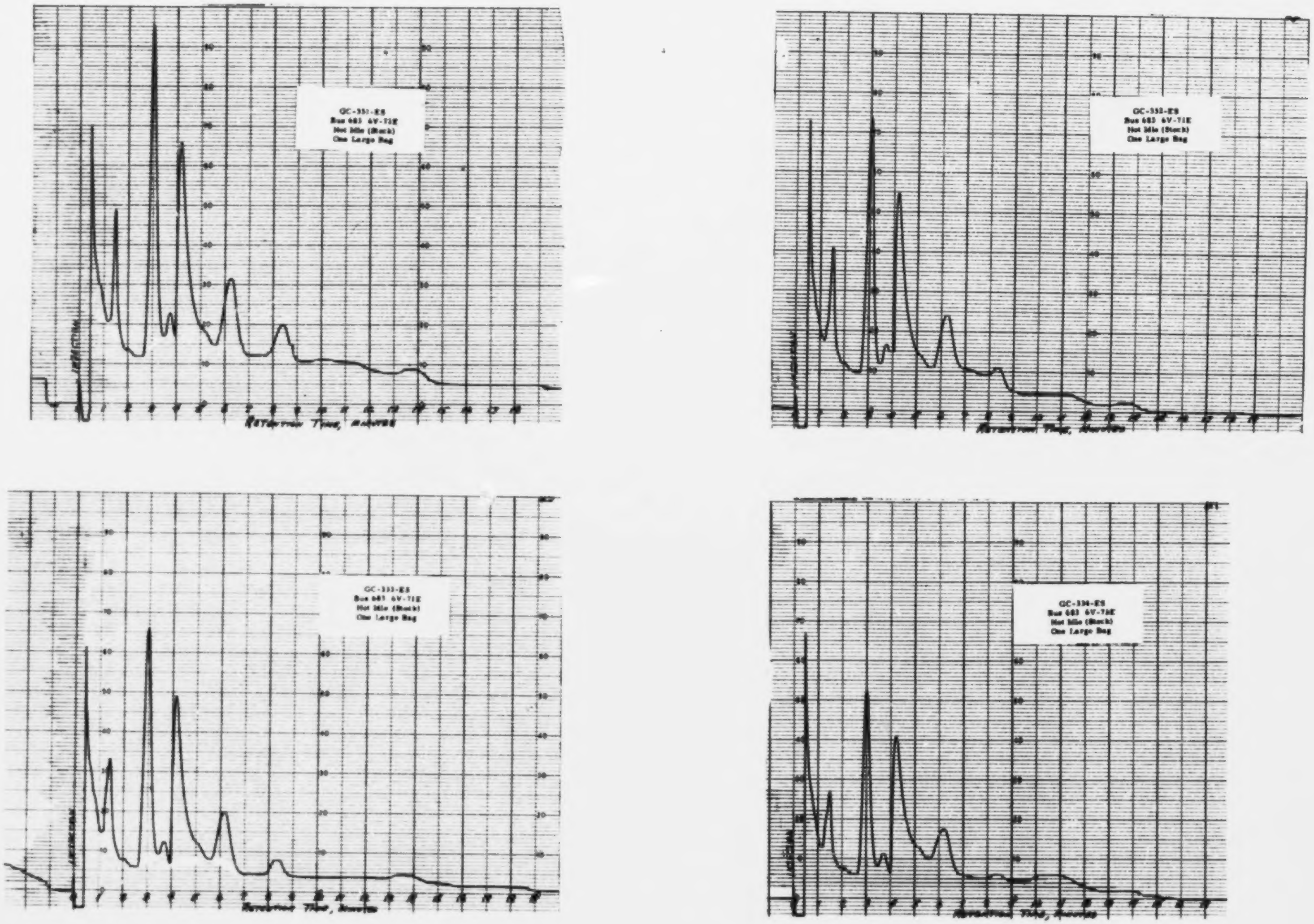


FIGURE 3. GAS CHROMATOGRAMS OF BUS 683 6V-71E EXHAUST CONDENSATE AT HOT IDLE (STOCK MUFFLER)--TRAPPED FROM ONE LARGE BAG (TRAPPED IMMEDIATELY AFTER SAMPLE OBTAINED)

TABLE 4. VEHICLE ODOR EVALUATION SUMMARY - CODE A
60N Injectors Installed

Vehicle: Bus 677
Date: April 30, 1969

Operating Conditions: See Tables 2 through 6, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	20 mph at 40 hp	3.6	1.0	1.0	0.7	0.3
5	" "	3.6	1.1	0.9	0.7	0.7
12	" "	4.8	2.4	1.0	0.9	0.8
16	" "	4.7	1.4	1.2	1.0	0.8
		4.2	1.5	1.0	0.8	0.7
4	30 mph at 40 hp	3.9	1.4	0.9	0.7	0.4
7	" "	3.1	1.0	0.9	0.9	0.1
11	" "	2.8	1.0	0.8	0.5	0.2
13	" "	4.1	1.2	0.9	0.9	0.8
		3.5	1.2	0.9	0.8	0.4
1	40 mph at 40 hp	4.1	1.1	1.1	0.9	0.7
8	" "	3.5	1.1	0.9	0.8	0.7
10	" "	4.3	1.2	0.9	0.9	0.4
15	" "	3.1	0.9	0.8	0.8	0.6
		3.8	1.1	0.9	0.9	0.6
3	Idle	5.1	1.9	1.1	1.6	0.7
6	"	5.1	1.7	1.4	1.1	0.7
9	"	4.0	1.3	0.9	0.9	0.9
14	"	5.6	1.9	1.4	1.0	0.9
		5.0	1.7	1.2	1.2	0.8
17	Idle-Acceleration	5.2	1.6	1.4	0.9	0.9
20	" "	5.2	1.5	1.3	1.3	0.9
21	" "	5.2	1.4	1.3	1.2	0.8
24	" "	5.1	1.7	1.4	1.0	0.8
		5.2	1.6	1.4	1.1	0.9
18	Deceleration	4.0	1.4	1.0	1.0	0.9
19	"	4.7	1.4	0.9	0.9	0.8
22	"	3.6	1.1	0.9	0.7	0.5
23	"	3.1	1.1	0.8	0.8	0.4
		3.9	1.3	0.9	0.9	0.7

TABLE 5. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS - CODE A

(As-Measured)

Vehicle: Bus 677
Date: April 30, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
20 mph	530	4.0	626	2.1	20.4	2.9	1051	1100	40
40 hp	590	4.0	557	2.2	18.4	3.6	1132	1060	35
	610	4.3	487	2.1	21.3	4.4	1051	1100	32
	530	4.3	464	2.1	19.4	4.4	936	1100	32
Average	565	4.2	544	2	20	4	1043	1090	35
30 mph	180	3.3	441	2.1	18.4	5.8	1063	870	35
40 hp	165	3.3	464	1.8	20.4	6.6	809	870	35
	130	3.4	338	1.8	19.2	5.8	843	870	32
	150	3.3	464	2.1	19.4	6.6	809	870	32
Average	156	3.3	427	2	19	6	881	870	34
40 mph	150	3.3	441	1.5	17.4	3.6	855	825	35
40 hp	130	3.1	557	1.9	19.4	9.5	785	720	32
	130	3.1	534	2.1	21.3	11.0	878	750	32
	130	3.2	464	1.8	20.4	8.0	820	720	32
Average	133	3.2	499	2	20	8	835	754	33
Idle	270	0.9	371	2.6	30.1	3.6	266	250	40
	270	0.9	371	2.3	31.0	3.6	266	250	44
	270	0.9	348	2.6	25.0	5.8	266	250	40
	270	0.9	325	2.4	32.0	4.4	266	280	35
Average	270	0.9	354	3	30	4	266	258	40

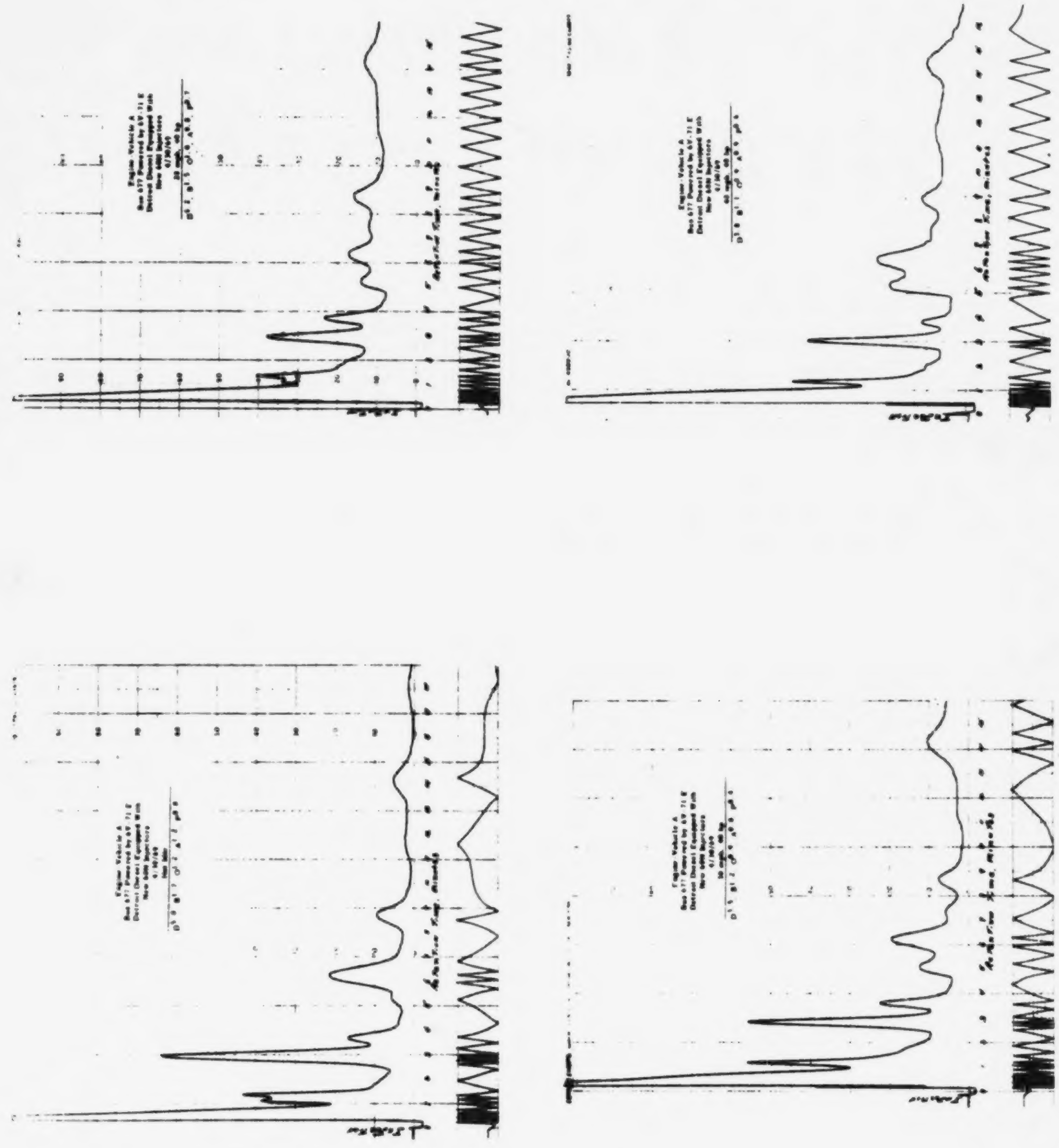


FIGURE 4. GAS CHROMATOGRAMS OF ENGINE-VEHICLE A

TABLE 6. VEHICLE ODOR EVALUATION SUMMARY - CODE B
Stock Muffler Installed

Vehicle: Bus 681
Date: May 28, 1969

Operating Conditions: See Tables 2 through 6, Appendix B
Fuel: EM-70-F (No. 1 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	20 mph at 40 hp	4.2	1.1	1.0	1.0	0.6
7	" "	5.0	1.7	1.3	1.1	0.2
12	" "	5.2	1.7	1.1	1.1	1.0
15	" "	5.5	1.9	1.2	1.1	0.9
		5.0	1.6	1.2	1.1	0.7
4	30 mph at 40 hp	4.3	1.1	1.1	1.0	0.7
5	" "	3.6	1.1	1.0	0.9	0.3
9	" "	4.3	1.0	1.0	1.0	0.6
16	" "	4.8	1.4	1.1	1.0	0.8
		4.3	1.2	1.1	1.0	0.6
2	40 mph at 40 hp	4.1	1.2	1.1	1.0	0.5
8	" "	4.9	1.6	1.2	0.9	0.3
10	" "	3.9	1.1	1.0	1.1	0.7
13	" "	4.8	1.4	1.3	1.0	1.0
		4.4	1.3	1.2	1.0	0.6
3	Idle	5.2	1.6	1.5	1.2	0.9
6	"	4.3	1.4	1.1	1.1	0.3
11	"	4.9	1.7	1.1	1.1	1.0
14	"	5.0	1.6	1.4	1.1	0.9
		4.9	1.6	1.3	1.1	0.8
18	Idle-Acceleration	6.6	2.1	1.7	1.5	1.1
20	" "	6.3	2.0	1.7	1.3	1.1
23	" "	6.2	2.1	1.6	0.9	1.3
24	" "	6.2	2.0	1.5	1.2	1.0
		6.3	2.1	1.6	1.2	1.1
17	Deceleration	6.1	2.0	1.7	1.4	0.9
19	"	6.8	2.1	1.8	1.5	1.1
21	"	6.8	2.0	1.9	1.5	1.4
22	"	5.9	1.9	1.8	1.5	1.2
		6.4	2.0	1.8	1.5	1.2

TABLE 7. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS - CODE B

(As-Measured)

Vehicle: Bus 681
Date: May 28, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
20 mph	1155	5.6	1462	4.7	33.0	11.0	889	790	49
40 hp	975	5.7	1253	5.1	30.3	9.6	878	790	58
	865	5.6	1160	4.9	33.6	10.0	889	825	54
	885	5.4	1183	5.9	33.8	12.0	832	825	54
Average	970	5.6	1265	5	33	11	872	808	54
30 mph	250	4.8	1067	3.7	16.5	5.9	739	640	54
40 hp	270	4.7	1114	3.8	17.5	7.3	612	640	54
	250	4.4	1090	3.5	16.9	7.5	762	600	54
	250	4.3	974	3.7	20.1	7.2	705	640	58
Average	255	4.6	1061	4	18	7	705	630	55
40 mph	215	4.6	882	3.5	25.3	9.6	647	570	49
40 hp	215	4.3	835	3.2	23.5	10.3	647	570	49
	215	4.3	905	3.2	16.9	9.1	624	570	49
	200	4.2	835	3.7	19.6	10.9	612	570	49
Average	211	4.4	864	3	21	10	633	570	49
Idle	235	1.2	534	3.3	18.5	6.6	219	175	58
	235	1.4	510	3.5	12.7	7.3	266	210	58
	235	1.1	487	3.1	20.1	7.6	219	210	54
	235	1.1	487	3.5	19.6	6.2	219	210	58
Average	235	1.2	505	3	18	7	231	201	57

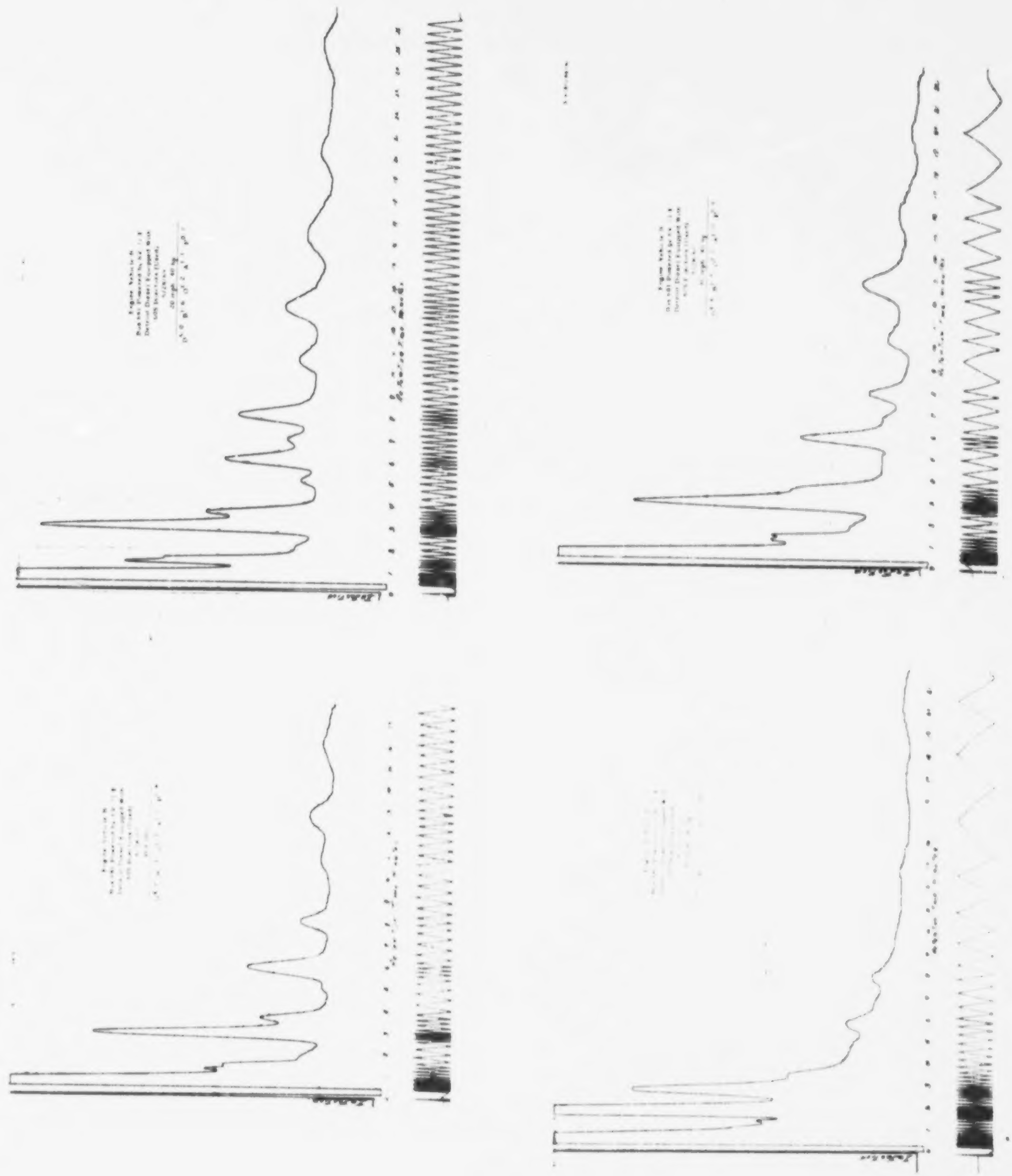


FIGURE 5. GAS CHROMATOGRAMS OF ENGINE-VEHICLE B

TABLE 8. ENGINE ODOR EVALUATION SUMMARY - CODE C

Engine: Cummins NH 220
Date: June 16, 1969

Fuel: EM-90-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
2	1500 rpm at 125 hp	3.5	1.2	1.0	0.7	0.3
5	" "	4.6	1.2	1.1	0.8	0.4
13	" "	4.2	1.3	1.0	0.7	0.5
16	" "	4.1	1.2	0.8	0.8	0.5
		4.1	1.2	1.0	0.8	0.4
3	1800 rpm at 125 hp	3.1	1.0	1.1	1.0	0.3
6	" "	4.5	1.5	1.0	1.0	0.2
9	" "	3.7	1.1	1.1	0.7	0.3
12	" "	3.5	1.1	0.7	0.6	0
		3.7	1.2	1.0	0.8	0.2
1	2100 rpm at 125 hp	4.7	1.5	1.0	1.0	0.3
8	" "	4.6	1.5	1.1	0.8	0.4
11	" "	4.8	1.6	1.2	0.7	0.7
15	" "	5.1	1.7	1.2	1.0	0.3
		4.8	1.6	1.1	0.9	0.4
4	Idle	4.7	1.3	1.1	1.0	0.8
7	"	4.6	1.2	1.1	0.8	0.6
10	"	5.2	1.8	1.2	1.0	0.8
14	"	5.0	1.6	1.5	1.1	0.5
		4.8	1.4	1.2	1.0	0.7

TABLE 9. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS - CODE C

(As-Measured)

Date: June 16, 1969

Engine: Cummins NH-220 Stationary Engine
Fuel: EM-90-F (No. 2 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
1500 rpm 125 hp	2	2668	9.4	77	4.7	35.7	17.5	1120	1100	36
	5	2668	8.9	128	4.5	33.7	15.3	1155	1180	36
	13	2784	8.9	106	4.9	32.3	14.8	1074	1220	32
	16	2784	8.9	106	5.1	33.7	17.3	1190	1260	32
Average		2726	9.0	104	5	34	16	1134	1190	34
1800 rpm 125 hp	3	1690	8.0	128	5.2	37.9	19.8	889	790	36
	6	1740	8.2	128	4.9	34.0	17.6	912	900	36
	9	1690	7.6	128	5.5	35.0	16.1	878	870	32
	12	1690	7.6	128	5.6	39.0	17.7	912	900	32
Average		1702	7.9	128	6	36	18	897	865	34
2100 rpm 125 hp	1	1560	8.2	129	5.1	39.8	19.1	693	600	32
	8	1440	7.5	153	5.6	38.8	19.1	693	640	36
	11	1440	7.3	180	5.6	39.0	19.1	693	640	32
	15	1410	7.3	154	5.6	41.2	20.0	670	680	32
Average		1464	7.6	154	6	40	19	687	640	33
Idle	4	235	1.2	166	3.5	37.9	15.4	162	140	27
	7	215	1.1	193	3.7	35.9	15.4	116	110	23
	10	215	1.1	166	3.6	35.1	13.2	162	140	23
	14	215	1.1	138	3.5	33.3	14.8	162	140	23
Average		220	1.1	166	4	35	15	150	132	24

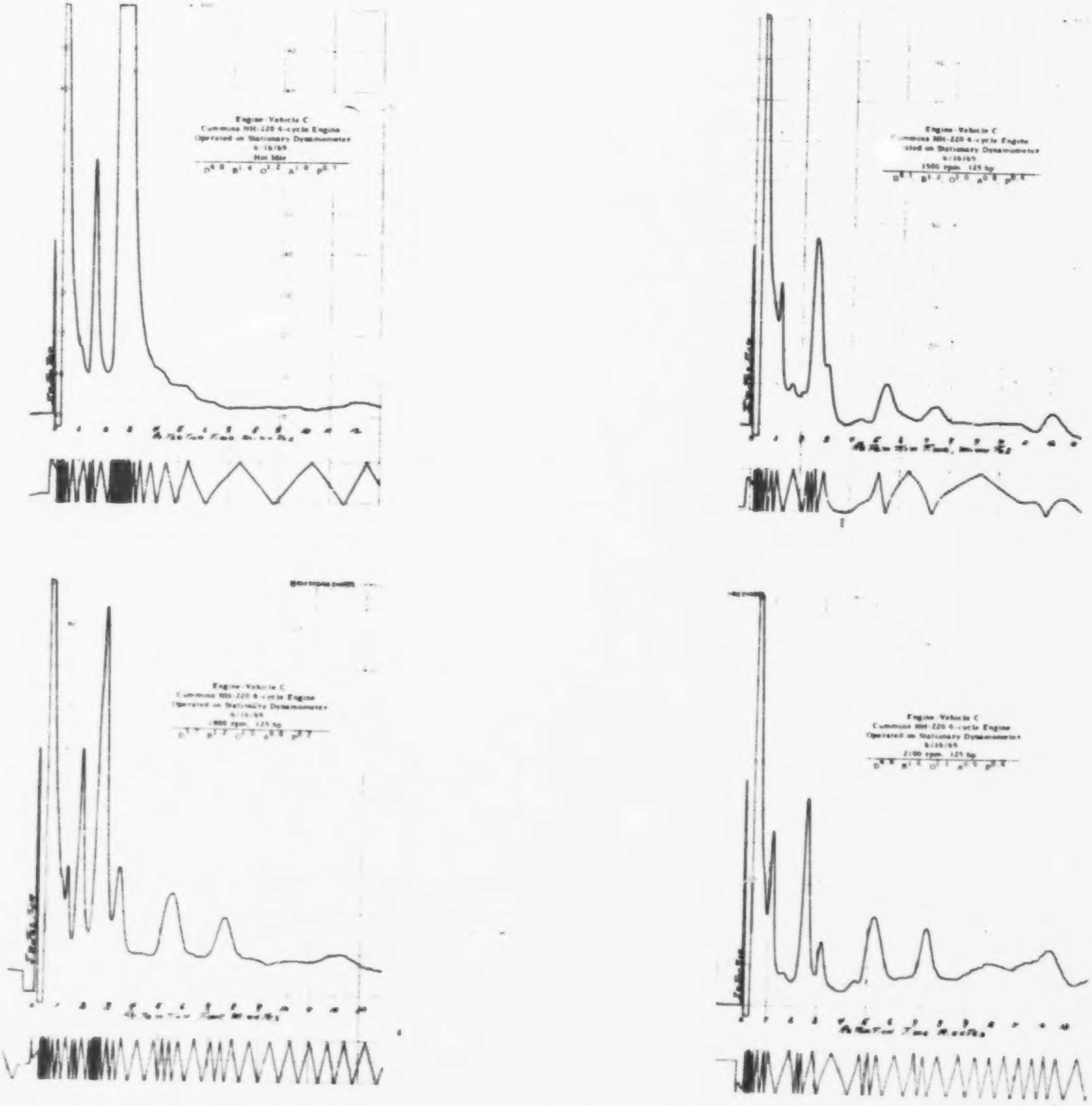


FIGURE 6. GAS CHROMATOGRAMS OF ENGINE-VEHICLE C

TABLE 10. VEHICLE ODOR EVALUATION SUMMARY - CODE D

Vehicle: 1964 GMC Tractor
Date: June 24, 1969

Engine: Detroit Diesel 8V-71
Fuel: EM-29-F (No. 2 Diesel)

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	1500 rpm at 160 hp	5.0	1.4	1.1	1.0	1.0
8	" "	4.3	1.3	1.2	1.0	0.9
10	" "	3.9	1.2	1.0	1.0	0.6
14	" "	4.6	1.2	1.2	0.8	0.8
		4.4	1.3	1.1	1.0	0.8
2	1800 rpm at 170 hp	3.8	1.0	1.0	1.0	0.4
5	" "	4.6	1.3	1.1	1.0	0.6
12	" "	4.1	1.2	1.2	1.0	0.7
13	" "	3.4	1.2	1.0	0.8	0.7
		3.9	1.2	1.1	1.0	0.6
1	2100 rpm at 180 hp	4.2	1.3	1.1	1.0	0.9
6	" "	3.2	1.1	1.1	1.0	0.4
11	" "	3.7	1.1	1.0	0.7	0.6
15	" "	3.9	1.1	1.0	1.0	0.4
		3.7	1.1	1.0	0.9	0.5
3	Idle	3.8	1.1	1.0	1.0	0.6
7	"	4.3	1.2	1.0	1.1	0.6
9	"	4.4	1.3	1.2	1.2	0.9
16	"	5.0	1.7	1.3	1.0	0.9
		4.3	1.3	1.1	1.0	0.7

TABLE 11 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS - CODE D

(As-Measured)

Vehicle: 1964 GMC Tractor
Date: June 24, 1969

Engine: Detroit Diesel 8V-71
Fuel: EM-29-F (No. 2 Diesel)
Dilution Ratio: 100:1

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
1500 rpm	4	1060	6.9	286	3.0	17.6	4.4	1386	1380	58
160 hp	8	2020	7.4	274	3.2	19.5	6.6	1351	1180	58
	10	2020	7.1	260	3.5	18.6	5.9	1386	1310	54
	14	2020	7.4	258	3.0	20.8	7.5	1328	1260	54
Average		1780	7.2	270	3	19	6	1362	1282	56
1800 rpm	2	360	7.1	260	2.2	15.5	7.3	1155	1320	49
170 hp	5	590	6.8	254	2.3	15.6	5.9	1282	1260	54
	12	760	7.1	296	2.6	16.7	7.4	1282	1340	51
	13	630	6.9	299	2.9	17.6	7.4	1363	1380	49
Average		585	7.0	277	3	16	7	1270	1325	51
2100 rpm	1	510	6.5	260	2.1	15.6	6.6	924	1125	51
180 hp	6	270	6.5	260	2.0	18.5	4.4	936	1060	54
	11	630	6.8	234	2.3	16.7	4.5	959	1180	49
	15	630	6.5	234	2.6	16.9	3.8	1051	1180	49
Average		510	6.5	247	2	17	5	967	1136	51
Idle	3	100	1.0	222	1.6	18.4	3.6	231	280	44
	7	70	0.9	249	2.2	16.6	4.4	231	320	40
	9	70	0.9	276	2.1	14.6	4.4	231	300	42
	16	70	1.0	193	2.2	14.9	3.8	231	320	35
Average		77	0.9	235	2	16	4	231	305	40

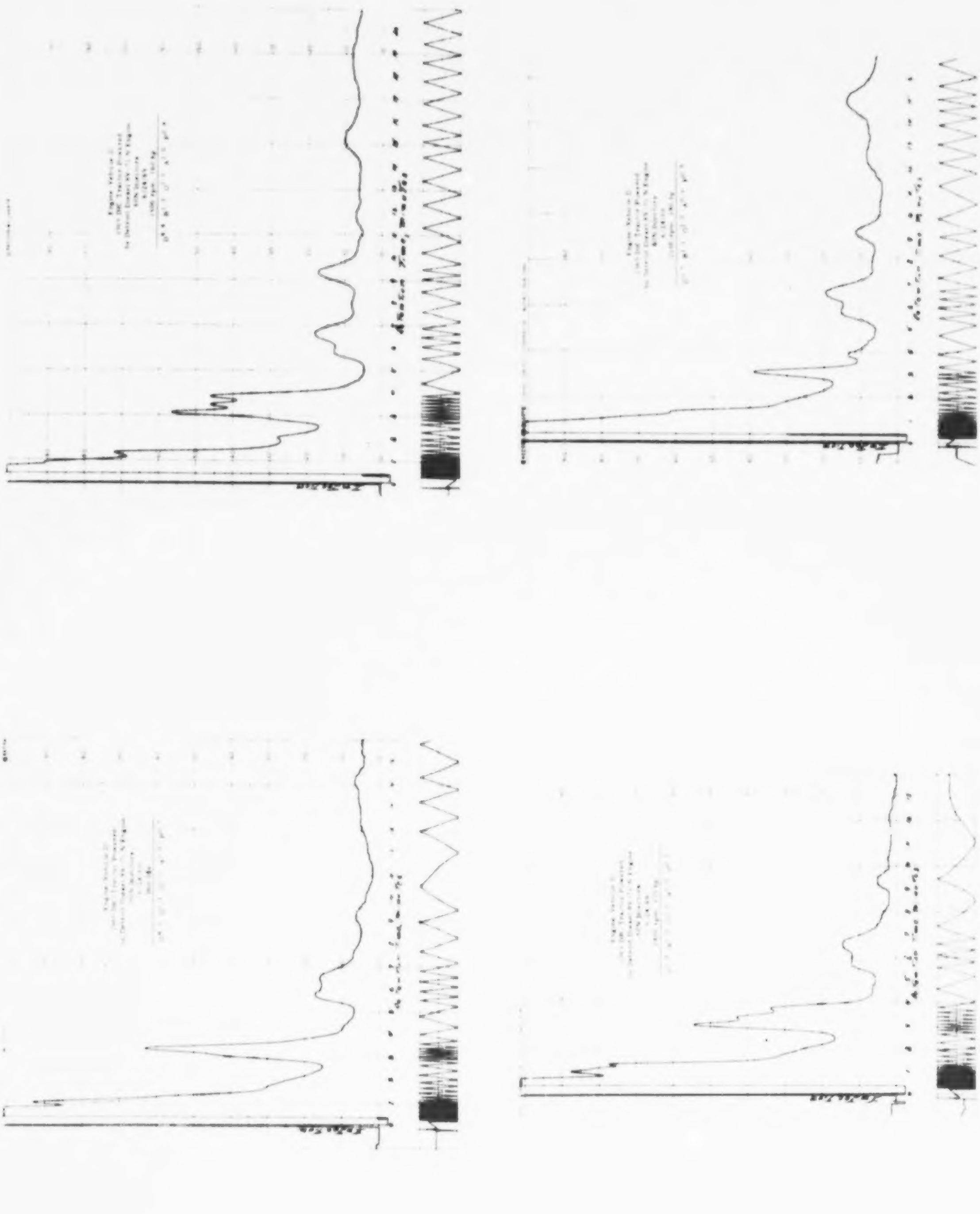


FIGURE 7. GAS CHROMATOGRAMS OF ENGINE-VEHICLE D

For Odor and Chemistry Results, See the Following

Engine-Vehicle Code	Appendix	Table No.	Description
E	G	8	Odor Summary
		9	Chemistry Summary
F	G	14	Odor Summary
		15	Chemistry Summary
G	G	16	Odor Summary
		17	Chemistry Summary
I	E	14	Odor Summary
		15	Chemistry Summary
J	E	13	Odor Summary
		15	Chemistry Summary

FIGURE 8. GAS CHROMATOGRAMS OF ENGINE-VEHICLE E

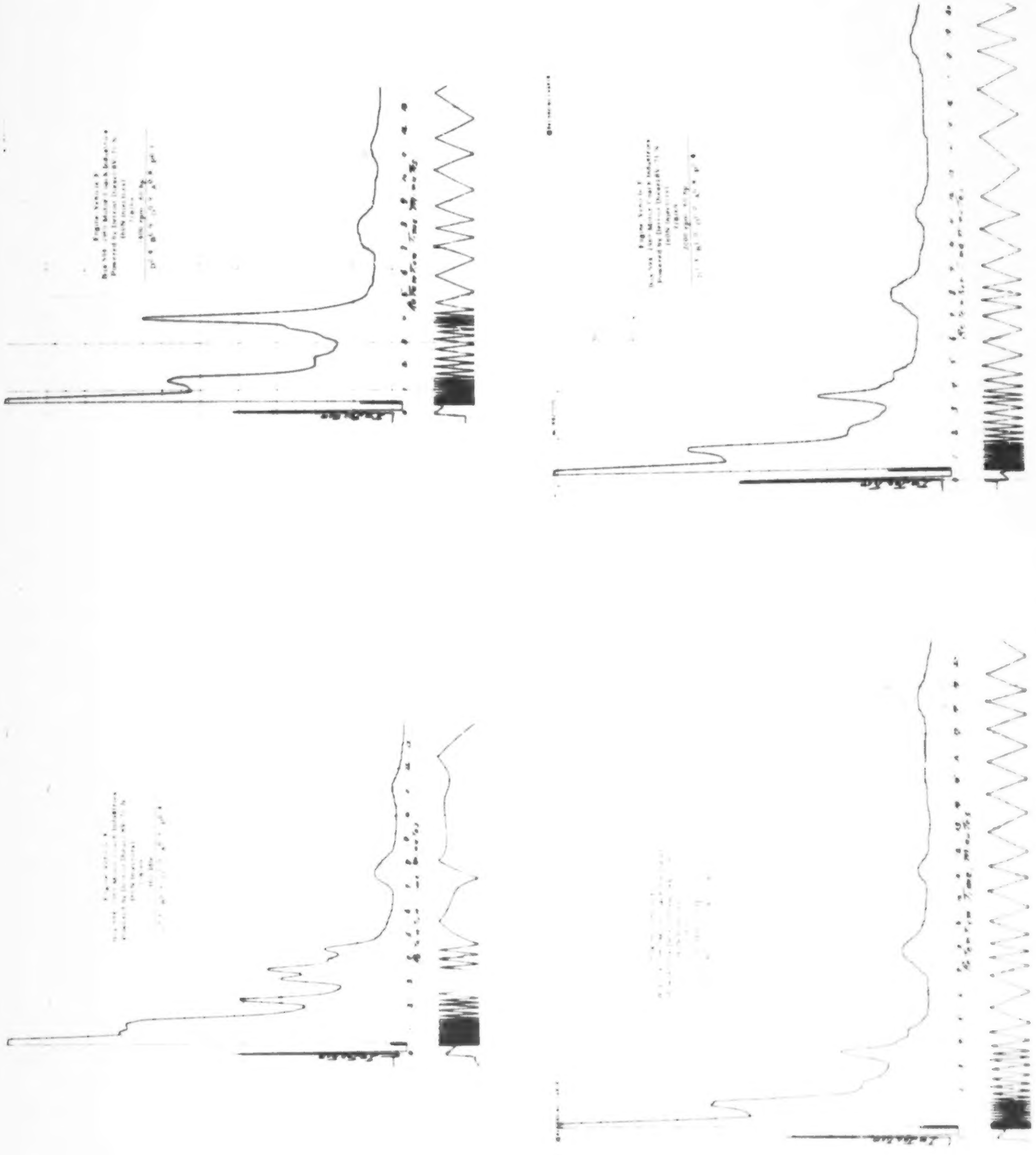


FIGURE 9. GAS CHROMATOGRAMS OF ENGINE-VEHICLE F

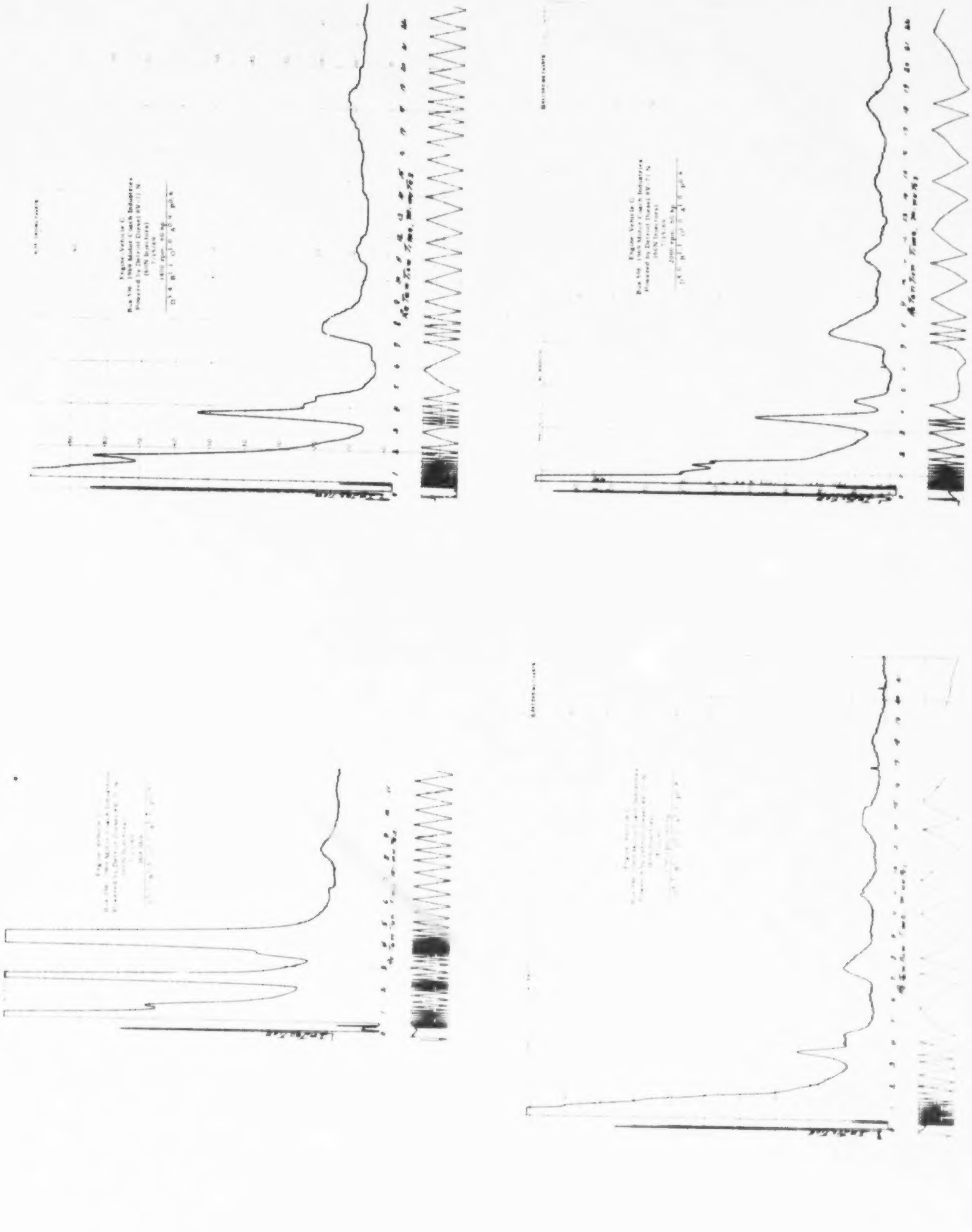


FIGURE 10. GAS CHROMATOGRAMS OF ENGINE-VEHICLE G

TABLE 12. VEHICLE ODOR EVALUATION SUMMARY - CODE H

Vehicle: 1968 Ford Tractor
Date: July 23, 1969

Fuel: EM-90-F (No. 2 Diesel)
Dilution Ratio: 100:1

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	1500 rpm at 150 hp	4.0	1.2	1.0	0.7	0.5
5	" "	4.3	1.5	1.0	0.8	0.7
10	" "	2.7	1.0	0.8	1.0	0.2
13	" "	2.2	0.8	0.7	1.0	0.3
		3.3	1.1	0.9	0.9	0.4
3	1800 rpm at 150 hp	3.5	1.2	1.0	0.7	0.8
7	" "	4.3	1.3	1.0	1.0	0.8
9	" "	4.0	1.3	0.8	0.8	0.8
15	" "	3.0	0.8	0.8	1.0	0.2
		3.7	1.2	0.9	0.9	0.7
2	2100 rpm at 150 hp	3.5	1.2	0.8	1.0	0.3
8	" "	2.8	1.2	0.8	1.0	0.3
12	" "	5.0	1.5	1.3	0.8	0.7
16	" "	4.0	1.5	1.0	0.8	0.5
		3.8	1.4	1.0	0.9	0.5
4	Idle	3.3	1.0	1.0	0.8	0.3
6	"	3.2	1.0	1.0	1.0	0.3
11	"	3.8	1.5	0.8	0.8	0.5
14	"	4.8	1.3	1.0	1.0	0.7
		3.8	1.2	1.0	0.9	0.5

TABLE 13. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS - CODE H

(As-Measured)

Vehicle: 1968 Ford Tractor
Date: July 23, 1969

Engine: Cummins NH-250
Fuel: EM-90-F (No. 1 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm	NO_2, ppm
1500 rpm 150 hp	1	1672	10.9	87	1.9	24.3	6.4	1652	1200	33
	5	2000	10.6	62	1.9	16.3	9.0	1617	1200	29
	10	1476	10.6	126	1.2	17.5	7.5	1501	1200	25
	13	1913	10.9	101	1.9	17.7	9.3	1478	1200	25
Average		1765	10.8	94	2	19	8	1562	1200	28
1800 rpm 150 hp	3	500	8.8	113	2.1	18.5	9.4	1167	850	30
	7	555	8.2	147	1.6	20.7	12.4	1236	900	29
	9	573	9.1	107	2.5	20.6	9.0	1074	900	20
	15	482	9.0	63	1.5	19.8	7.5	1236	900	20
Average		528	8.8	108	2	20	10	1178	888	25
2100 rpm 150 hp	2	518	8.4	133	2.7	21.3	9.7	843	625	29
	8	592	9.1	141	2.9	24.0	12.4	866	600	25
	12	537	9.0	63	2.7	24.4	5.9	912	625	25
	16	500	8.5	62	2.0	19.8	8.4	970	300	20
Average		537	8.8	100	3	22	9	898	538	25
Idle	4	134	1.3	141	2.3	17.3	7.7	104	175	25
	6	119	1.3	89	2.5	22.6	13.0	116	75	14
	11	134	1.1	101	1.9	25.4	9.3	116	100	12
	14	134	1.1	107	1.9	20.9	7.5	139	125	12
Average		130	1.2	110	2	22	9	119	119	16

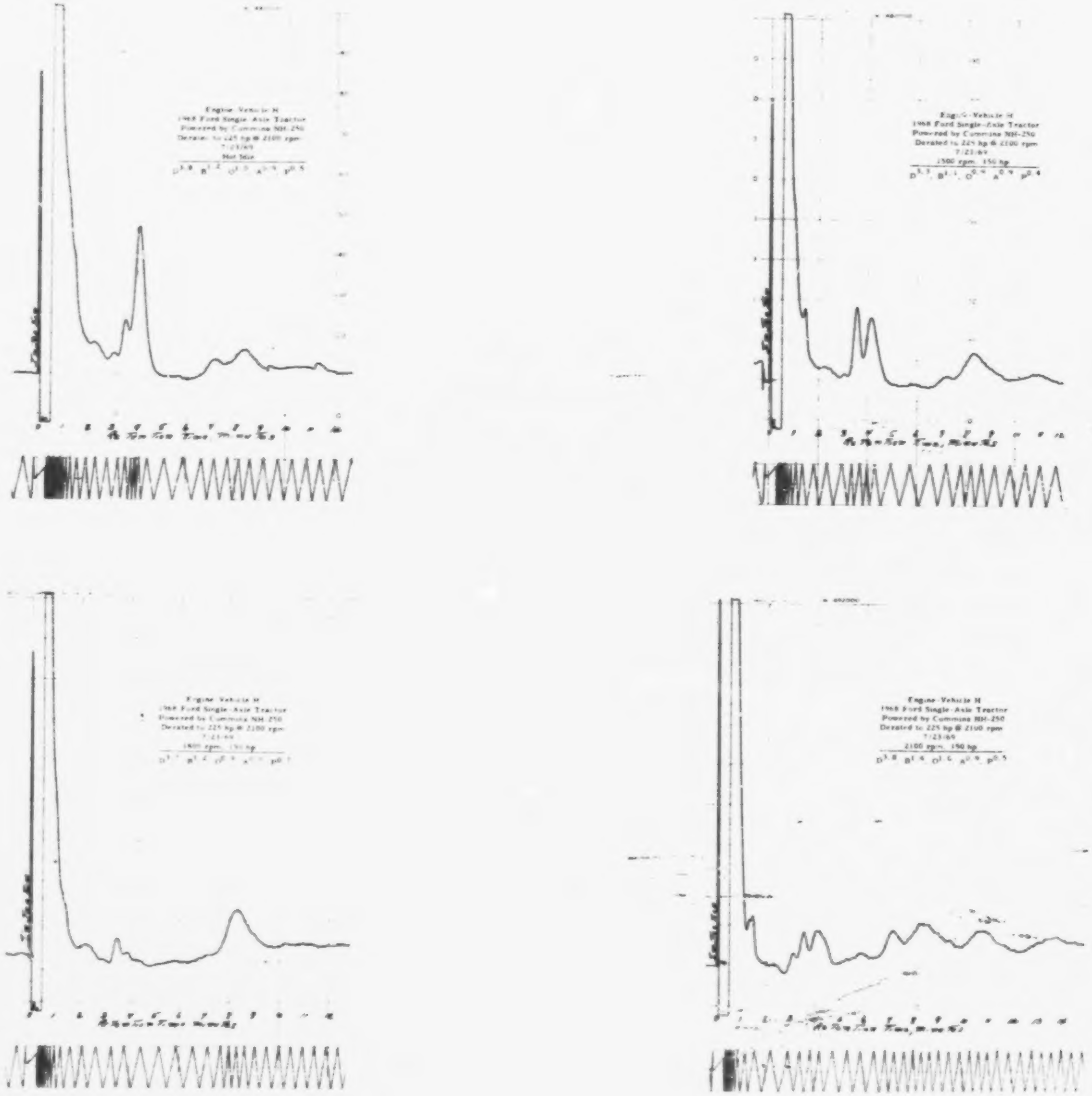


FIGURE 11. GAS CHROMATOGRAMS OF ENGINE-VEHICLE H

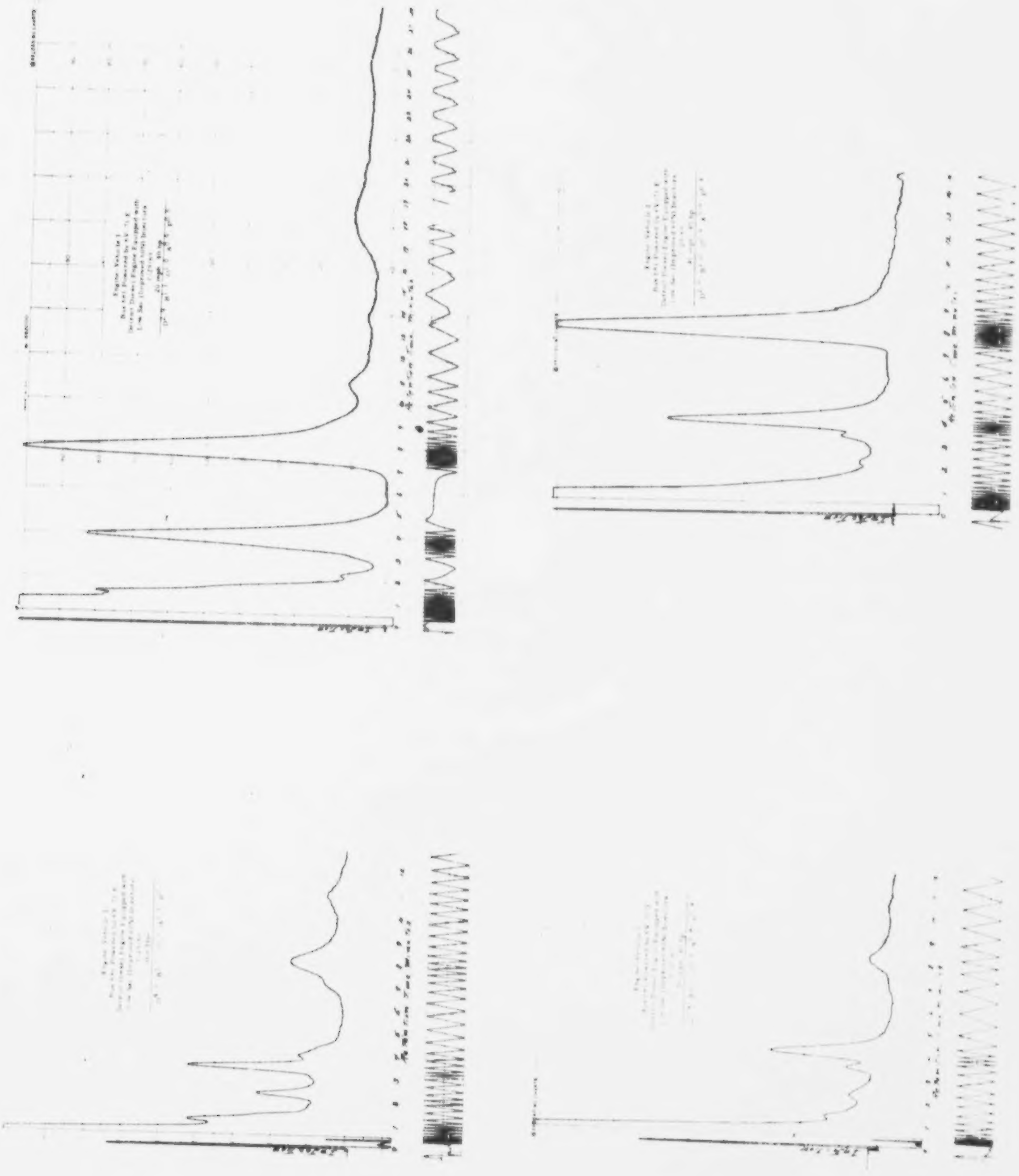


FIGURE 12. GAS CHROMATOGRAMS OF ENGINE-VEHICLE I

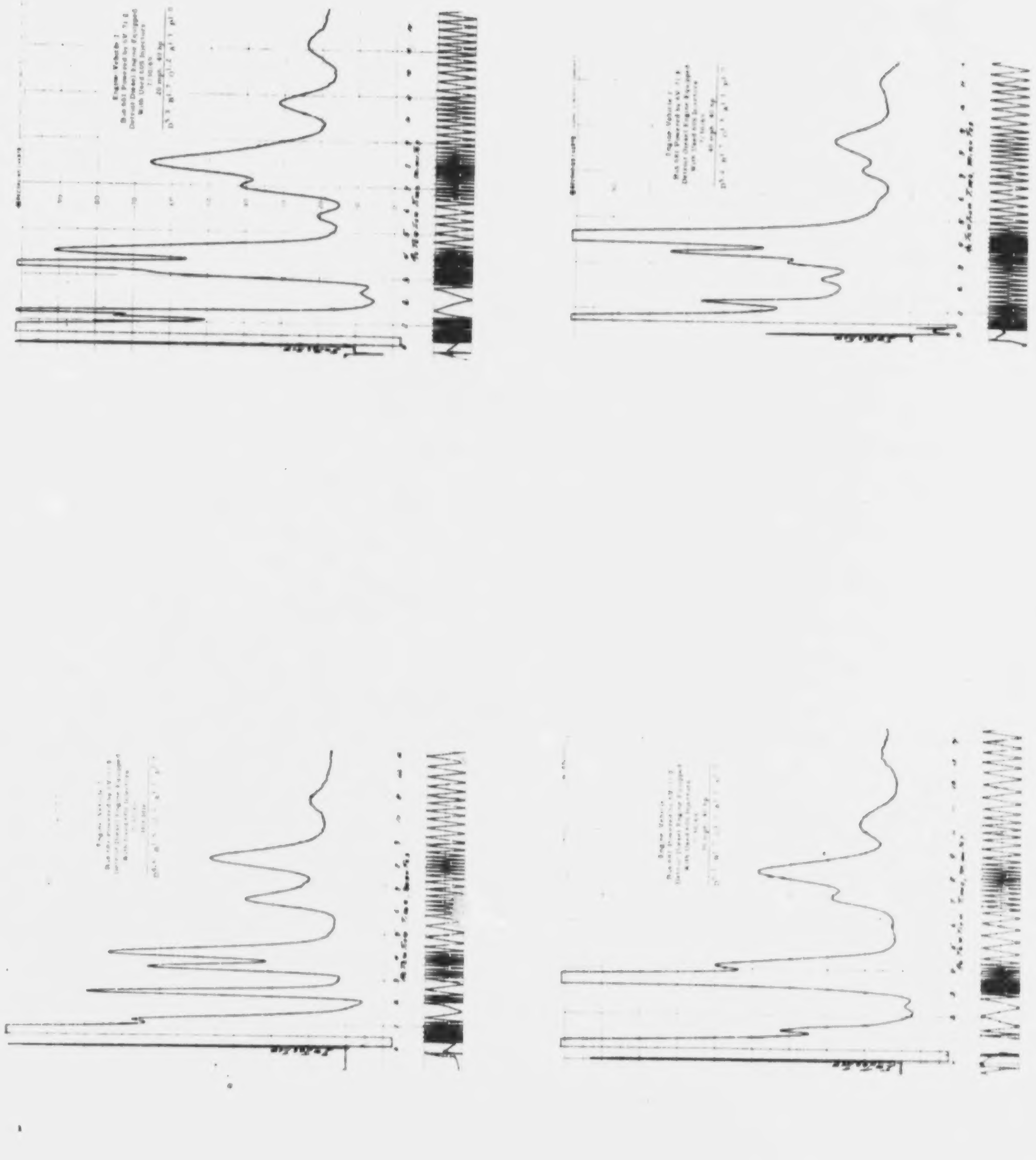


FIGURE 13. GAS CHROMATOGRAMS OF ENGINE-VEHICLE J

TABLE 14. VEHICLE ODOR EVALUATION SUMMARY - CODE K

Vehicle: 1965 White Freightliner
Date: August 6, 1969

Fuel: EM-90-F (No. 2 Diesel)
Dilution Ratio: 100:1

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
1	1500 rpm at 150 hp	4.5	1.3	1.2	1.0	0.8
6	" "	5.0	1.4	1.4	1.0	0.9
12	" "	4.3	1.2	1.0	0.9	0.8
14	" "	2.7	1.3	1.0	1.0	0.5
		4.1	1.3	1.2	1.0	0.8
2	1800 rpm at 150 hp	2.5	1.0	1.0	0.9	0.4
8	" "	3.5	1.4	1.0	1.0	0.6
9	" "	3.6	1.0	1.0	0.9	0.5
13	" "	2.9	1.0	1.0	0.9	0.5
		3.1	1.1	1.0	0.9	0.5
3	2100 rpm at 150 hp	4.0	1.2	1.0	1.0	0.8
7	" "	5.1	1.4	1.2	1.0	0.9
10	" "	3.8	1.2	1.0	1.0	0.9
15	" "	4.5	1.3	1.2	0.9	0.8
		4.4	1.3	1.1	1.0	0.9
4	Idle	5.1	1.3	1.2	0.9	0.9
5	"	4.5	1.4	1.2	1.0	0.9
11	"	4.9	1.3	1.2	1.0	0.8
16.	"	5.0	1.6	1.4	1.0	1.0
		4.9	1.4	1.3	1.0	0.9

TABLE 15 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS - CODE K

(As-Measured)

Vehicle: ABC Truck 220 Cummins
Date: August 6, 1969

Fuel: EM-90-F (No. 2 Diesel)
Dilution Ratio: 100:1

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehydes, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1500 rpm	1	2000	11.4	199	1.2	13.8	2.1	1224	1275
150 hp	6	2000	11.6	224	0.4	9.8	0	1294	1350
	12	2000	11.8	191	3.4	15.5	1.5	1386	1425
	14	2000	11.8	248	3.1	14.4	1.5	1478	1475
Average		2000	11.7	216	2	13	1	1345	1381
1800 rpm	2	2000	11.1	188	1.1	11.0	0	1247	1175
150 hp	8	2000	11.1	149	0.5	11.8	0.7	1247	1175
	9	2000	12.0	211	4.9	10.8	1.4	1282	1225
	13	2000	11.3	211	5.0	14.7	4.8	1317	1225
Average		2000	11.4	190	3	12	2	1273	1200
2100 rpm	3	2000	10.2	163	0.3	12.0	0	912	875
150 hp	7	2000	9.9	175	0.6	15.2	0.7	993	825
	10	2000	10.1	251	4.0	12.4	5.1	936	900
	15	2000	10.1	225	3.7	15.5	2.4	959	925
Average		2000	10.1	204	2	14	2	950	881
Idle	4	164	1.3	124	0.1	13.2	0.7	127	150
	5	156	1.3	166	0.5	12.5	0	139	150
	11	156	1.3	207	1.4	19.7	4.3	150	150
	16	164	1.4	138	1.4	18.2	6.5	139	150
Average		160	1.3	159	2	16	3	138	150

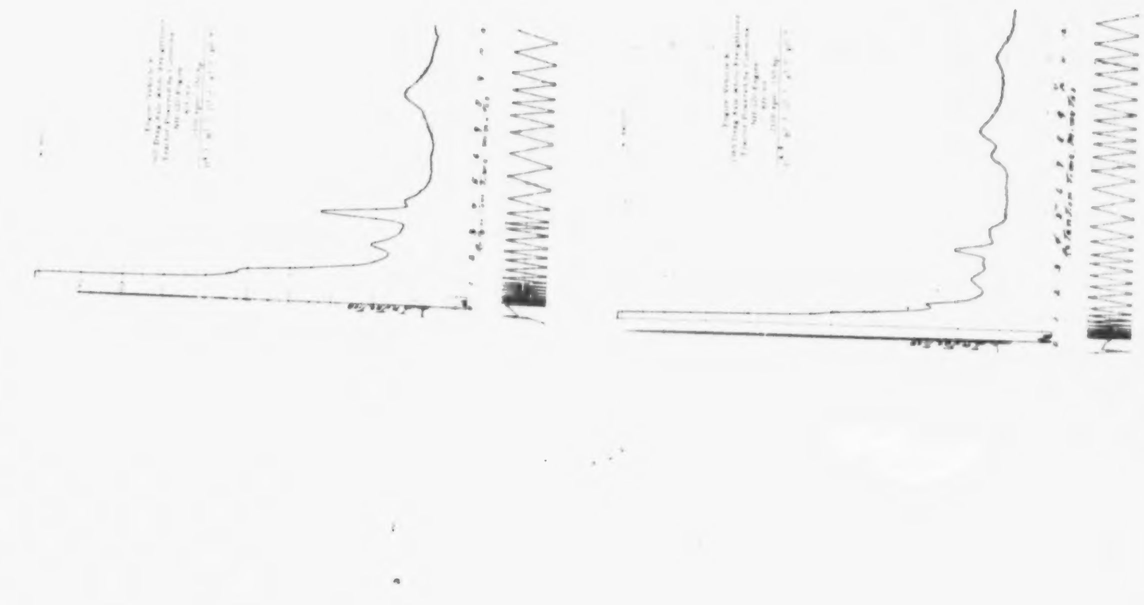


FIGURE 14. GAS CHROMATOGRAMS OF ENGINE-VEHICLE K

APPENDIX G

ODOR, SMOKE AND OTHER EMISSIONS FROM AN INTERCITY COACH

TABLE 1. DESCRIPTION OF MCI INTERCITY COACHES EVALUATED

Vehicle Data:			
Bus Number	598	594	596
Manufacturer	Motor Coach Industries	Motor Coach Industries	Motor Coach Industries
Model	MC-5A	MC-5A	MC-5A
Source	S. A. Transit	S. A. Transit	S. A. Transit
Air Conditioned	Yes	Yes	Yes
Year	1969	1969	1969
Engine Data:			
Manufacturer	Detroit Diesel General Motors	Detroit Diesel General Motors	Detroit Diesel General Motors
Engine Number	8V-71N	8V-71N	8V-71N
Cycles	2	2	2
Horsepower Rating at 2100 rpm	280	280	280
Cylinder/Arrangement	8/V	8/V	8/V
Compression Ratio	18.7:1	18.7:1	18.7:1
Displacement, cubic inches	568	568	568
Bore and Stroke, inches	4-1/4 × 5	4-1/4 × 5	4-1/4 × 5
Number of Exhaust Valves	4	4	4
Type Injectors	Unit	Unit	Unit
Injector Size	60N	60N	60N
Engine Maintenance:			
Total Miles (Start of Test)	30,090	11,807	1,803
Miles Since Injector Change	30,090	11,807	1,803
Miles Since Major Overhaul	Original	Original	Original
Drive Line Data:			
Transmission	DANA	DANA	DANA
Number of Forward Speeds	4	4	4
Rear Axle	MCI Special	MCI Special	MCI Special
Rear Axle Ratio	3.36:1	3.36:1	3.36:1
Number of Drive Axles	1	1	1
Tire Size	11.00 × 20	11.00 × 20	11.00 × 20

TABLE 2. CONSTANT SPEED DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: MCI Coach Model MC-5A bus powered by Detroit Diesel 8V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.

Vehicle Speeds and Loads: The following are to be run with the transmission in 2nd gear under full inertia simulation, air conditioning "off."

Vehicle Speed, mph	Engine Speed, rpm	Vehicle Load, hp
20	1400	60
25	1700	60
30	2000	60

Procedure:

(1) Operate at given stable speed and load for 15 seconds.

(2) Turn "on" 45-second panel warning light, turn dilution system to "auto" control and continue stable operation.

(3) Ring bell for panel to begin odor evaluation and maintain stable operation.

(4) Panel turns "off" light when evaluation is complete. The evaluation requires 50 to 70 seconds to complete.

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with 2 to 3 exposures (sniffs) at will during the approximately 60-second period.

(5) When light goes "off," turn dilution system to "man" control and decelerate to idle. Permit rear tires to rotate and cool.

(6) Wait 5 minutes between runs for panel rest, tire cooling, and orifice change. (Time starts when light goes "out.")

Run Time: Approximately 3 minutes; with 5-minute rest, 8 minutes.

TABLE 3. ENGINE IDLE DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability:	MCI Coach Model MC-5A bus powered by Detroit Diesel 8V-71 engine.
Sample Method:	Constant sample flow at 100:1 dilution level.
Warm-up:	A minimum of three complete runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.
Vehicle Speed and Load:	Operate at 25 mph and 60 hp for 1 minute followed by engine idle. (Air conditioning off and with inertia simulation.)
Procedure:	(1) Operate at 25 mph and 60 hp, stable. (2) Turn "on" panel warning light and maintain stable operation. (3) After 1 minute of stable sustained operation, allow engine to idle. (4) Turn dilution system to "auto" 2 seconds after start of idle. (5) Ring bell to begin panel exposure 15 seconds after start of idle. (6) Panel turns "off" light when evaluation is complete. The evaluation requires 50 to 70 seconds to complete. Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with 2 to 3 exposures (sniffs) at will during the approximately 60-second period. (7) When light is "off," turn dilution system to "man" control and permit rear tires to rotate and cool. (8) Wait 5 minutes between runs for panel rest, tire cooling, and orifice change. (Time starts when light goes "out.")
Run Time:	Approximately 3 minutes; with 5-minute rest, 8 minutes.

TABLE 4. IDLE-ACCELERATION DIESEL ODOR QUALITY/ INTENSITY EVALUATION PROCEDURE

Applicability: MCI Coach Model MC-5A bus powered by Detroit Diesel 8V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.

Inertia: Full inertia simulation via SwRI system.

Vehicle Speed and Load: Idle for 1 minute followed by full-rack acceleration to 16 mph with inertia only.

Procedure:

(1) Turn "on" 60-second panel warning light, turn dilution system to "auto" and idle for 1 minute, rear wheels stationary.

(2) Accelerate full rack in 1st gear to 16 mph under full inertia simulation.

(3) Ring bell for panel exposure 3 seconds after start of acceleration

(4) Hold 16 mph for 15 seconds, turn off engine and turn dilution system to "man."

(5) Two minutes after turning "off" engine, start engine and allow to idle. Turn on 60-second panel warning light and turn dilution system to "auto." Allow to idle for 1 minute, rear wheels stationary.

(6) Repeat items (2) through (5) above. The original and repeat idle-acceleration constitute one run.

(7) Wait 5 minutes between runs for panel rest, tire cooling, and orifice change. (Time starts when engine is turned "off.")

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with an original and a repeat exposure (sniff).

Run Time: Approximately 6.5 minutes; with 5-minute rest, 11.5 minutes.

TABLE 5. CONSTANT SPEED-DECELERATION DIESEL ODOR QUALITY/INTENSITY EVALUATION PROCEDURE

Applicability: MCI Coach Model MC-5A bus powered by Detroit Diesel 8V-71 engine.

Sample Method: Constant sample flow at 100:1 dilution level.

Warm-up: A minimum of three runs should be conducted prior to odor evaluation to assure the engine and system have reached operating temperature.

Inertia: Full inertia simulation via SwRI system.

Vehicle Speed and Load: Operate in 2nd gear at stable 30 mph and 60 hp for 1 minute followed by closed-rack deceleration with full inertia simulation, air conditioning "off."

Procedure:

(1) Operate at 30 mph and 60 hp, stable.

(2) Turn "on" 60-second panel warning light, turn dilution system to "auto" and maintain stable operation.

(3) After 1 minute of stable sustained operation, closed-rack decelerate.

(4) Ring bell for panel exposure at 20 mph.

(5) Continue deceleration to 10 mph, declutch and permit engine to idle and cool tires. Turn "off" light and turn dilution system to "man."

(6) Two minutes after downshift, return to 30 mph and 60 hp condition.

(7) Repeat items (2) through (5) above. The original and repeat constant speed-deceleration constitute one run.

(8) Wait 5 minutes between runs for panel rest, tire cooling, and orifice change. (Time starts on engine downshift.)

Note: The panel evaluates the dilute diesel exhaust sample for the overall diesel composite and each of the four qualities with only an original and a repeat exposure (sniff).

Run Time: Approximately 7 minutes; with 5-minute rest, 12 minutes.

TABLE 6. CONSTANT SPEED DIESEL SMOKE EVALUATION PROCEDURE

Applicability: MCI Coach Model MC-5A bus powered by Detroit Diesel 8V-71 engine.

Measurement Method: U.S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches from tip of 4-inch diameter exhaust pipe.

Warm-up: A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator, if used, removed.

Inertia: Full inertia simulation via SwRI system.

Vehicle Speeds and Loads: The following are to be run:

Vehicle Speed, mph	Transmission Gear No.	Engine Speed, rpm Approx	Power Load
20	3rd	800	Open rack
25	3rd	1000	Open rack
30	3rd	1200	Open rack
35	3rd	1400	Open rack
40	3rd	1600	Open rack
45	3rd	1800	Open rack
50	3rd	2000	Open rack

Procedure:

(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 SCFM of purge air to collimating tubes.

(2) Start engine and accelerate to 3rd gear and load vehicle back to 20 mph at open rack maximum horsepower. After 30 seconds of stable operation, note the average maximum smokemeter reading.

(3) Release some load in the water brake dynamometer and allow vehicle speed to increase to 25 mph. After 30 seconds of stable operation, note the average maximum smokemeter reading.

(4) Using the procedure in (3), similarly operate at 30, 35, 40, 45, and 50 mph.

(5) Repeat items (1) through (4) two times.

TABLE 7. IDLE-ACCELERATION DIESEL SMOKE EVALUATION PROCEDURE

Applicability:	MCI Coach Model MC-5A bus powered by Detroit Diesel 8V-71 engine.
Measurement Method:	U.S. Public Health Service full-flow light-extinction type smokemeter located 5-1/2 inches from tip of 4-inch diameter exhaust pipe.
Warm-up:	A minimum of three runs should be conducted prior to smoke evaluation to assure the engine and system have reached operating temperature. Air conditioning "off" and rack compensator, if used, removed.
Inertia:	Full inertia simulation via SwRI system.
Vehicle Speed and Load:	Idle for 1 minute followed by full-rack acceleration to 60 mph with inertia and initially preset dynamometer load.
Procedure:	(1) Zero potentiometric recorder and 100-percent adjust smokemeter with engine "off" using 2 SCFM of purge air to collimating tubes. (2) Start engine and allow to idle for one minute. Note maximum smoke at start on recorder. (3) After one minute of idle, full-rack accelerate using normal driving habit and shifting to 40 mph against inertia and the initially set load of 60 hp at 30 mph in the water brake type dynamometer. (4) Note the maximum smoke during each gear used during acceleration. (5) Repeat steps (1) through (4) above two times.

TABLE 8. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: MCI Coach No. 598 Fuel: EM-90-F (No. 2 Diesel)
Date: July 1, 1969

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	1400 rpm at 60 hp	1.9	0.7	0.9	0.7	0.3
8	" "	2.7	0.7	0.9	0.7	0.3
9	" "	1.9	0.9	0.6	0.4	0.3
15	" "	2.7	1.0	0.6	0.9	0.3
		2.3	0.8	0.7	0.7	0.3
3	1700 rpm at 60 hp	2.7	0.6	1.0	0.9	0.3
6	" "	3.3	0.9	0.9	0.9	0.4
11	" "	2.6	0.9	0.6	0.7	0.3
13	" "	2.3	0.7	0.4	0.7	0.6
		2.7	0.8	0.7	0.8	0.4
2	2000 rpm at 60 hp	2.6	0.9	0.6	0.7	0.1
7	" "	3.9	1.0	1.0	0.9	0.6
12	" "	2.7	0.9	0.9	0.7	0.1
14	" "	2.4	0.6	0.6	0.9	0.1
		2.9	0.8	0.9	0.8	0.2
1	Idle	4.1	1.3	1.0	1.0	0.3
5	"	4.3	1.3	1.0	0.9	0.9
10	"	3.7	1.1	1.0	0.9	0.6
16	"	4.4	1.4	1.0	1.0	0.6
		4.1	1.3	1.0	1.0	0.6
17	Idle-Acceleration	3.4	0.7	1.1	1.0	0.4
18	" "	5.9	2.0	1.6	1.0	0.9
21	" "	5.9	2.0	1.3	1.3	1.0
23	" "	6.0	2.0	1.6	0.9	1.1
		5.3	1.6	1.4	1.0	0.8
19	Deceleration	6.1	2.0	1.6	1.3	0.9
20	"	4.7	1.6	1.6	1.3	0.9
22	"	5.0	1.9	1.1	1.1	0.4
24	"	5.1	1.7	1.3	1.3	0.7
		5.2	1.8	1.4	1.3	0.7

TABLE 9 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: Bus 598
Date: July 1, 1969

Fuel: EM-90-F (No. 2 Diesel)

Operating Conditions	Runs No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehyde, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1400 rpm	4	130	3.8	417	2.5	13.0	3.0	716	720
20 mph	8	115	3.6	443	2.6	13.0	3.8	866	770
60 hp	9	115	3.6	391	2.6	13.0	3.8	901	700
	15	105	3.8	497	2.3	12.0	3.8	901	720
Average		116	3.7	437	3	13	4	846	727
1700 rpm	3	130	3.8	404	2.5	13.0	3.0	739	640
25 mph	6	130	3.9	443	2.3	15.1	3.8	809	720
60 hp	11	100	3.9	431	2.6	12.0	3.0	797	740
	13	100	3.8	470	2.6	13.0	3.8	739	740
Average		115	3.9	437	3	13	3	771	710
2000 rpm	2	140	3.8	391	3.1	14.0	3.8	762	590
30 mph	7	130	3.9	417	3.1	13.0	3.8	705	620
60 hp	12	115	3.9	431	3.1	13.0	3.8	762	620
	14	105	3.9	510	3.0	12.0	3.8	716	700
Average		122	3.9	437	3	13	4	736	632
Idle	1	165	1.1	470	2.8	16.1	7.6	277	220
	5	160	1.0	497	2.8	15.1	5.3	254	220
	10	115	1.0	510	3.1	16.1	6.1	254	280
	16	120	1.0	537	2.8	15.1	6.1	219	300
Average		140	1.0	504	3	16	6	251	255

TABLE 10. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: MCI Coach No. 578 Fuel: EM-70-F (No. 1 Diesel)
Date: July 2, 1969

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	1400 rpm at 60 hp	3.7	0.9	0.9	0.8	0.2
8	" "	3.2	1.0	0.9	0.7	0.3
9	" "	4.8	1.4	1.1	1.1	0.7
15	" "	3.0	0.8	1.0	0.7	0.2
		3.6	1.0	1.0	0.8	0.3
3	1700 rpm at 60 hp	3.0	0.9	0.9	0.8	0.1
6	" "	3.9	1.0	1.1	1.0	0.3
11	" "	3.0	1.0	1.0	0.9	0.1
13	" "	2.8	0.9	1.0	0.4	0.1
		3.1	1.0	1.0	0.7	0.1
2	2000 rpm at 60 hp	3.0	1.0	1.0	0.7	0
7	" "	4.0	1.1	1.1	1.0	0.2
12	" "	3.1	1.1	1.0	1.0	0.3
14	" "	5.2	1.6	1.4	0.9	0.7
		3.8	1.2	1.1	0.9	0.3
1	Idle	2.7	0.9	0.9	0.9	0.2
5	"	4.3	1.2	1.0	1.0	0.3
10	"	2.6	0.7	1.1	0.8	0
16	"	3.4	1.1	1.0	0.6	0.4
		3.2	0.9	1.0	0.8	0.2
17	Idle-Acceleration	5.1	1.3	1.3	1.2	1.0
18	" "	6.3	2.0	1.8	1.6	1.1
21	" "	4.0	1.2	1.1	1.0	0.6
23	" "	5.8	2.0	1.7	1.3	1.1
		5.3	1.6	1.4	1.2	0.9
19	Deceleration	5.6	1.7	1.8	1.4	0.9
20	"	5.6	1.8	1.3	1.1	0.8
22	"	5.2	1.7	1.4	1.1	0.7
24	"	5.2	1.9	1.6	1.1	0.7
		5.4	1.8	1.5	1.2	0.8

TABLE 11. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Fuel: EM-70-F (No. 1 Diesel)

Vehicle: Bus 598
Date: July 2, 1969

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehyde, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1400 rpm	3	160	3.9	652	3.2	21.8	5.2	739	675
20 mph	8	150	3.9	600	3.2	22.1	5.3	762	675
60 hp	12	140	3.8	573	3.1	21.4	4.6	762	740
	13	160	4.0	573	3.1	23.4	4.6	762	740
Average		152	3.9	600	3	22	5	756	707
1700 rpm	1	170	3.9	496	3.5	20.1	4.6	693	640
25 mph	7	165	4.0	573	3.7	22.1	5.3	612	600
60 hp	10	180	4.0	522	3.5	22.1	6.1	693	600
	15	150	3.8	548	3.5	21.1	4.6	647	640
Average		166	3.9	545	4	21	5	661	620
2000 rpm	2	170	3.9	652	3.1	18.1	6.1	693	570
30 mph	6	165	3.9	666	3.2	17.1	5.3	647	570
60 hp	11	165	3.8	652	3.0	17.1	5.3	647	550
	16	170	3.8	522	3.2	18.1	5.3	670	600
Average		167	3.9	623	3	18	6	664	572
Idle	4	200	1.0	561	3.7	23.1	10.6	185	250
	5	180	0.9	548	3.8	22.1	10.6	219	230
	9	180	1.0	522	3.8	23.1	9.1	219	220
	14	200	1.0	587	3.7	24.1	6.1	208	250
Average		190	1.0	555	4	23	9	207	237

TABLE 12. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: MCI Coach No. 594 Fuel: EM-70-F (No. 1 Diesel)
Date: July 9, 1969

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	1400 rpm at 60 hp	2.4	1.0	0.7	0.7	0.3
8	" "	3.6	1.0	1.0	0.9	0.7
12	" "	2.6	0.9	1.0	0.9	0.3
13	" "	3.0	1.0	1.0	1.1	0.7
		2.9	1.0	0.9	0.9	0.5
1	1700 rpm at 60 hp	1.6	0.9	0.9	0.3	0.1
7	" "	2.4	1.0	1.0	1.0	0.6
10	" "	3.4	1.0	1.0	1.0	0.1
15	" "	2.6	1.1	1.0	0.9	0.2
		2.5	1.0	1.0	0.8	0.2
2	2000 rpm at 60 hp	3.1	0.9	1.0	0.7	0.4
6	" "	3.6	1.1	1.0	1.0	0.4
11	" "	3.0	1.0	1.0	1.0	0.3
16	" "	4.7	1.3	1.0	0.8	0.7
		3.6	1.1	1.0	0.9	0.4
4	Idle	3.9	1.0	1.0	0.9	0.7
5	"	3.7	1.1	1.0	1.0	0.6
9	"	4.4	1.1	1.0	1.0	0.6
14	"	4.8	1.6	1.1	1.0	0.6
		4.2	1.2	1.0	1.0	0.6
18	Idle-Acceleration	6.1	2.0	1.6	1.4	1.1
20	" "	5.1	1.4	1.2	0.9	1.0
23	" "	5.2	1.7	1.4	1.0	0.9
24	" "	4.8	1.8	1.6	1.2	1.0
		5.3	1.7	1.4	1.1	1.0
17	Deceleration	3.6	1.0	1.0	0.9	0.1
19	"	3.9	1.0	1.1	1.0	0.7
21	"	3.7	1.1	1.0	0.8	0.4
22	"	3.7	1.4	1.1	0.9	0.3
		3.7	1.1	1.1	0.9	0.3

TABLE 13 SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: Bus 594
Date: July 9, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehyde, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1400 rpm	3	180	3.8	417	4.2	26.1	2.3	889	680
20 mph	8	180	3.8	443	4.1	25.1	3.0	901	790
60 hp	12	180	3.9	470	4.1	23.1	2.3	924	790
	13	180	3.9	443	4.1	23.1	3.8	936	825
Average		180	3.9	443	4	24	3	913	771
1700 rpm	1	180	3.8	322	4.2	26.8	3.8	705	720
25 mph	7	180	4.1	338	4.3	26.1	3.8	658	640
60 hp	10	180	3.9	295	4.2	25.4	3.9	751	720
	15	200	3.9	312	4.1	26.1	3.8	705	720
Average		185	3.9	317	4	26	4	705	700
2000 rpm	2	200	3.8	261	4.0	26.1	3.0	716	640
30 mph	6	200	4.1	261	4.3	26.1	3.8	693	570
60 hp	11	200	3.9	234	4.1	25.4	3.9	762	680
	16	180	4.1	234	4.2	27.5	3.9	681	530
Average		195	4.0	248	4	26	4	716	605
Idle	4	215	0.9	391	4.8	28.1	5.3	231	220
	5	235	0.9	403	4.7	26.4	5.4	219	175
	9	235	1.0	312	4.8	26.4	5.4	231	220
	14	235	0.9	391	4.7	25.4	4.6	254	220
Average		230	0.9	374	5	27	5	234	209

TABLE 14. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: MCI Coach No. 594 Fuel: EM-90-F (No. 2 Diesel)
Date: July 8, 1968

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	1400 rpm at 60 hp	2.2	0.7	1.0	0.8	0.3
8	" "	2.7	1.0	0.6	0.8	0.1
12	" "	2.5	0.8	1.0	0.7	0
13	" "	2.3	1.1	1.1	0.8	0.1
		2.4	0.9	0.9	0.8	0.1
1	1700 rpm at 60 hp	2.8	0.8	1.0	0.8	0.2
6	" "	3.6	1.2	1.0	0.7	0.2
11	" "	2.5	0.7	0.9	0.8	0.1
15	" "	3.0	1.1	0.9	0.6	0.3
		2.9	0.9	1.0	0.7	0.2
2	2000 rpm at 60 hp	3.0	1.0	1.0	0.7	0.2
7	" "	4.0	1.0	1.0	1.0	0.5
10	" "	2.6	1.0	1.0	0.8	0.3
16	" "	3.7	1.0	1.0	0.8	0.5
		3.3	1.0	1.0	0.8	0.4
4	Idle	4.0	1.0	1.0	1.0	0.3
5	"	3.3	0.7	1.0	0.8	0.3
9	"	3.6	1.0	1.0	0.9	0.5
14	"	3.5	1.0	1.0	1.0	0.3
		3.6	0.9	1.0	0.9	0.4
17	Idle-Acceleration	5.3	1.8	1.3	1.2	1.0
19	" "	5.8	1.8	1.7	1.1	1.1
21	" "	6.1	1.0	1.7	1.3	1.0
22	" "	6.7	2.2	1.7	1.3	1.2
		6.0	1.7	1.6	1.2	1.1
18	Deceleration	3.5	1.0	0.8	0.7	0.5
20	"	4.1	1.0	1.0	1.1	0.8
23	"	4.8	1.8	1.0	1.1	0.7
24	"	4.6	1.5	1.0	0.8	0.8
		4.2	1.3	1.0	0.9	0.7

TABLE 15. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: Bus 594
Date: July 8, 1969

Fuel: EM-90-F (No. 2 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehyde, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1400 rpm	3	150	3.8	209	4.1	16.0	3.8	739	600
20 mph	8	150	4.1	209	4.2	15.0	2.3	774	680
60 hp	12	150	4.1	182	4.2	14.0	3.0	809	680
	13	150	4.2	287	4.1	16.0	3.0	797	720
Average		150	4.1	222	4	16	3	779	670
1700 rpm	1	150	4.1	228	4.2	14.0	4.6	751	600
25 mph	6	150	4.2	261	4.3	13.0	3.8	797	640
60 hp	11	150	4.2	235	4.2	14.0	3.8	809	640
	15	165	4.2	261	4.1	14.0	3.8	728	640
Average		153	4.2	246	4	14	4	771	632
2000 rpm	2	150	4.1	235	4.1	17.1	3.8	693	640
30 mph	7	165	4.3	235	4.2	15.0	4.6	705	600
60 hp	10	165	4.2	235	4.1	16.0	3.8	705	600
	16	165	3.9	235	4.0	15.0	3.8	658	680
Average		161	4.1	235	4	16	4	690	630
Idle	4	180	1.2	313	4.5	18.3	5.4	243	250
	5	180	1.2	287	4.3	17.3	4.6	231	220
	9	165	1.2	326	4.3	18.3	4.6	231	250
	14	180	1.2	365	4.4	19.3	5.3	231	220
Average		176	1.2	323	4	18	5	234	235

TABLE 16. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: MCI Coach No. 596 Fuel: EM-70-F (No. 1 Diesel)
Date: July 15, 1969

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
3	1400 rpm at 60 hp	2.4	1.0	1.0	0.7	0.3
8	" "	3.7	1.1	1.0	1.0	0.8
12	" "	3.6	1.1	1.0	1.0	0.8
13	" "	4.0	1.0	1.0	1.0	0.6
		3.4	1.1	1.0	0.9	0.6
1	1700 rpm at 60 hp	4.2	1.1	1.0	1.1	0.9
6	" "	4.6	1.0	1.1	1.1	0.7
11	" "	4.4	1.2	1.0	1.0	0.8
15	" "	3.8	1.1	1.1	1.1	0.8
		4.3	1.1	1.1	1.1	0.8
2	2000 rpm at 60 hp	3.3	1.1	0.9	0.7	0.6
7	" "	4.1	1.0	1.0	1.0	0.8
10	" "	3.9	1.0	1.0	1.0	0.8
16	" "	4.7	1.2	1.1	1.2	0.9
		4.0	1.1	1.0	1.0	0.8
4	Idle	4.9	1.3	1.0	1.2	0.9
5	"	5.2	1.6	1.1	1.0	1.0
9	"	5.1	1.7	1.2	1.3	0.9
14	"	5.2	1.6	1.2	1.2	0.9
		5.1	1.6	1.1	1.2	0.9
17	Idle-Acceleration	6.0	1.9	1.7	1.2	1.1
19	" "	5.6	1.6	1.8	1.1	1.0
21	" "	4.7	1.4	1.2	1.1	1.0
22	" "	4.1	1.3	1.0	0.9	0.9
		5.1	1.6	1.4	1.1	1.0
18	Deceleration	4.2	1.3	1.0	1.1	0.9
20	"	4.1	1.1	1.0	1.1	1.0
23	"	4.0	1.3	1.0	1.1	0.8
24	"	3.7	1.3	1.0	1.1	0.8
		4.0	1.3	1.0	1.1	0.9

TABLE 17. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: Bus 596 MCI#3
Date: July 15, 1969

Fuel: EM-70-F (No. 1 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehyde, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1400 rpm	3	147	3.8	615	3.7	13.0	6.1	947	725
20 mph	8	147	4.1	641	3.7	11.0	6.1	947	825
60 hp	12	164	3.7	694	3.8	13.2	6.9	924	825
	13	164	4.2	749	3.6	12.0	6.8	901	825
Average		156	3.9	675	4	12	6	930	800
1700 rpm	1	147	4.0	746	4.0	12.0	5.3	924	775
25 mph	6	164	4.2	749	4.0	12.0	6.1	901	760
60 hp	11	164	4.1	694	3.8	12.2	5.4	924	760
	15	164	4.0	668	3.8	12.2	6.2	878	760
Average		160	4.1	714	4	12	6	907	764
2000 rpm	2	164	4.2	668	4.0	12.0	5.3	693	725
30 mph	7	180	4.4	641	3.8	12.0	6.1	716	725
60 hp	10	164	4.4	691	4.0	11.2	5.4	739	725
	16	180	4.2	691	4.0	12.2	6.2	716	725
Average		172	4.3	673	4	11	6	716	725
Idle	4	197	1.0	481	4.3	28.5	8.5	254	250
	5	197	1.0	470	4.4	28.5	7.7	277	250
	9	197	1.0	534	4.7	27.5	7.7	254	210
	14	197	1.0	508	4.3	28.5	10.8	231	250
Average		197	1.0	498	4	28	9	254	240

TABLE 18. VEHICLE ODOR EVALUATION SUMMARY

Vehicle: MCI Coach No. 596 Fuel: EM-90-F (No. 2 Diesel)
Date: July 16, 1969

Run No.	Operating Conditions	"D" Composite	"B" Burnt	"O" Oily	"A" Aromatic	"P" Pungent
4	1400 rpm at 60 hp	2.7	1.0	1.0	0.7	0.2
5	" "	3.1	0.9	0.9	1.1	0.2
12	" "	4.5	1.1	1.0	1.1	0.3
15	" "	2.3	1.0	1.0	1.0	0.4
		3.1	1.0	1.0	1.0	0.3
2	1700 rpm at 60 hp	4.4	1.2	1.0	1.1	0.5
7	" "	3.8	1.1	1.1	1.1	0.4
11	" "	4.2	1.2	1.0	1.0	0.7
13	" "	4.2	1.4	1.1	1.1	0.6
		4.1	1.2	1.1	1.1	0.5
3	2000 rpm at 60 hp	3.2	1.2	1.1	0.7	0.3
8	" "	2.5	1.1	1.1	1.0	0.4
10	" "	4.1	1.2	1.0	1.0	0.5
14	" "	3.3	1.0	1.0	1.0	0.5
		3.2	1.1	1.1	0.9	0.4
1	Idle	3.4	1.1	1.0	0.8	0.3
6	"	3.2	1.1	1.1	1.0	0.6
9	"	3.6	1.2	1.1	0.8	0.2
16	"	4.7	1.2	1.1	1.1	0.7
		3.7	1.2	1.1	0.9	0.4
18	Idle-Acceleration	5.3	1.4	1.3	1.3	0.8
20	" "	5.4	1.2	1.2	1.2	1.0
23	" "	5.6	1.7	1.6	1.1	1.0
24	" "	7.0	2.0	1.7	1.4	1.0
		5.8	1.6	1.5	1.3	1.0
17	Deceleration	3.7	1.2	1.0	1.1	0.1
19	"	3.4	1.4	1.2	0.7	0.6
21	"	3.6	1.1	1.0	1.0	0.7
22	"	4.0	1.1	0.9	0.7	0.4
		3.7	1.2	1.0	0.9	0.5

TABLE 19. SUMMARY OF EXHAUST EMISSIONS MEASUREMENTS

(As-Measured)

Vehicle: Bus 596, MCI#3
Date: July 16, 1969

Fuel: EM-90-F (No. 2 Diesel)

Operating Conditions	Run No.	CO, ppm	CO_2, percent	HHC, ppm	Acrolein, ppm	Aliphatic Aldehyde, ppm	Formaldehyde, ppm	NO_x, ppm	NO, ppm
1400 rpm	4	164	4.4	374	3.2	16.3	6.9	947	760
20 mph	5	164	4.4	360	2.8	15.3	10.8	947	760
60 hp	12	164	4.2	374	3.1	14.0	11.4	947	725
	15	164	4.2	374	3.0	13.2	12.3	924	760
Average		164	4.3	371	3	15	10	941	751
1700 rpm	2	164	4.5	534	3.6	17.1	12.9	832	680
25 mph	7	180	4.2	401	3.3	13.2	14.6	901	640
60 hp	11	180	4.2	534	3.1	13.2	14.6	832	680
	13	180	4.2	507	3.2	16.3	13.1	855	680
Average		176	4.3	494	3	15	14	855	670
2000 rpm	3	164	4.5	401	3.5	13.2	9.2	855	680
30 mph	8	164	4.4	401	3.5	13.2	11.6	762	640
60 hp	10	164	4.1	388	3.6	17.3	11.6	809	640
	14	164	4.2	374	3.3	14.2	14.6	739	640
Average		164	4.3	391	4	14	12	791	650
Idle	1	197	1.3	470	3.6	15.3	6.2	277	250
	6	197	1.1	374	3.7	17.3	11.6	300	250
	9	197	1.1	401	3.7	14.2	13.1	277	210
	16	197	1.0	414	3.6	16.0	11.4	231	210
Average		197	1.1	415	4	16	11	271	230